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Cover Photo: Clarence Synder W3PYF has superbly stated the need for CW for the Amateur Extra License.
December's cover did not have full credits. The equipment shown is as follows: Amphenol Model 870 Millivolt Commander, McCoy 9 MHz filter and crystals, a variety of Amphenol connectors. The dog and Santa were constructed almost entirely of Amphenol connectors and sockets by John Gove. The Transceivers are readily identified.

Editorial Statement: Any errors found in this magazine are put there deliberately. We try to publish something for everyone and some people merely read the magazine to find errors.

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Departments

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de W2NSD/1

The other day an amateur stopped by for a short visit to 73 headquarters and mentioned that he had been conducting an investigation of our bands and had discovered that many of the contacts that were going on seemed to be rather pointless. Frankly I have to admit that this is not the first time that I've heard rumors about this.

When something like this develops to the point where we become aware of it here at 73 we like to see what we can do to correct it before it turns into a trend and the ARRL requests the FCC to legislate against it.

The first step, obviously, was to conduct a survey and try to find out the extent of the incipient trouble. The entire 73 staff was pressed into service on an intensive investigation of our bands. I am happy to report that our figures show that only about 98.7% of the contacts on the amateur bands are dull and boring both to the participants and the non-participating listeners. This was an encouraging discovery since first estimates had placed the figure somewhere over 99.3%.

A well known amateur psychiatrist was consulted and he pointed out that even though the contacts are obviously almost totally without content that they fulfill a basic need to communicate and thus do serve to satisfy a subconscious need. He went on to say that the vacuity of the contacts seems to eventually become evident to the participants on some level of awareness and that this has a strong tendency to decrease their activity, eventually terminating their amateur activities completely. After a few years of freedom from the deadening dullness of the average radio contacts many amateurs, driven by the subconscious need to communicate, find themselves getting back into their old hobby. The pattern repeats itself.

Pressed for some explanation for the dullness of contacts, our psychiatrist friend revealed that this results from a common but little-noticed phenomenon: mike fright. In the case of the CW operator it might be called key fright. It is a manifestation of the broadcast radio obsession against having any dead air. The operator is so afraid that he will not be able to think of something to talk about that he is actually unable to think of something to talk about. To fill in the time he does the obvious thing, he recites a list of the equipment that he is using and discusses the weather. Then, with a great sigh of relief, he turns it over to the other fellow. The other chap does exactly the same, leaving operator number one with nothing whatever to comment on and the prospect of either sitting there with his transmitter on trying to think of something to talk about or else asking for a QSL and signing off.

The pattern, which apparently had its roots in the early days of amateur radio, may just possibly be broken. Perhaps it is worth a try. Actually the difficulty isn't all that different from the everyday efforts we make to communicate with people in our business and family worlds. Cocktail parties can be murder if you don't know some secrets for getting people to talk. Despite articles in the Reader's Digest and in many books telling us that the way to open any conversation is to merely get the other fellow to talk about himself, we seem to forget this basic rule. I've tried this on the air many times and it has seldom failed to open up an interesting QSO. I ask about the line of work and any other interests or hobbies . . . and the lid is off. Of course this means that you have to be good at listening. If you have a good set of your own interests the chances are that you will find a common subject that you can hash over with enjoyment. If not, then perhaps you can get your contact to tell you about somebody he knows that interests you.

Still, this is a hap-hazard system. Perhaps it can be developed a bit into something less chancy. Wouldn't it be nice if you could dial a frequency and find fellows there that share your interests? Ham pilots seem to enjoy swapping stories with other pilots when they chance to get together on the air. How about setting up a "net" frequency of pilots?

There are thousands of ham boaters, stinkpot and windy types. Some like houseboats, some water ski, some skin dive, some race.

(*Turn to pg.* 104)

The Suppressor Compressor

The Neglected Grid

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We hams, just like most people, are prone to be creatures of habit. To illustrate my own personal groove, consider the pentode, a tube with three lovely grids plus other assorted parts. All my life I have fed a signal into the control grid, tied the screen to some B plus point and consigned the suppressor to ground or the top of the cathode bias resistor. There came the day when the painful process of thinking turned me out from my rut of indifference with interesting results. I knew from past tinkering that the screen was useful to control low frequency response in modulators and the like via the selective bypassing route. This in itself was perhaps the beginning of shrugging off old devil habit as the approach was a change from bypassing the screen and forgetting it. I decided to explore the personality of the suppressor and thereby hangs the tale.

The junk box supplied a small chassis with three octal sockets, to serve as a breadboard. The tube locker provided a 6SJ7 as the available pentode with the suppressor coming out to its own pin rather than being internally connected to some other element. As a jumping off point, I wired up the tube with average parts values for the tube used as an audio voltage amplifier as shown in **Fig. 1.**

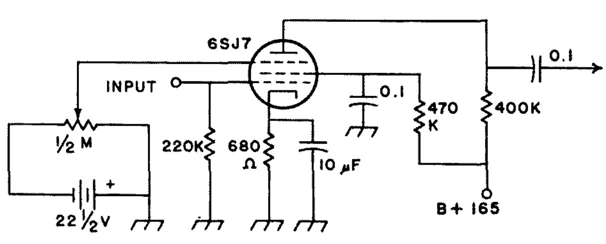

Fig. 1. Basic circuit of the Compressor, showing how a DC control voltage is applied to the suppressor *grid to control tube gain.*

Naturally the 22½ volt battery and the pot across it are not what you expect to find the well dressed voltage amplifier wearing but they were necessary to get some idea of what the suppressor characteristics would be. Increasing negative voltage on the suppressor brought to light one of those self evident truths "we all know". As the suppressor went more negative the plate voltage rose and the screen voltage fell. A little cogitating on the location of the suppressor, between the screen and the plate explains the foregoing. As the negative suppressor shuts off the electron stream to the plate, the screen becomes the dominant attractor, its current goes up and the voltage drop through the screen resistor goes up. Ergo! Since the project now showed promise of improving my education I forged on. The next addition was to be a triode amplifier following the pentode stage so that I could get enough voltage, signal wise, to use my db meter. With the addition of a 6J5 triode the circuit now looked like **Fig. 2.**

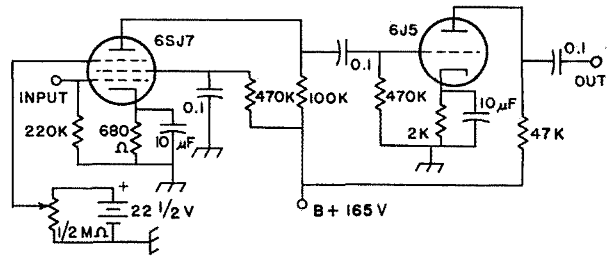

Fig. 2. This arrangement would be appropriate for remote control of audio gain. It has an effective control range of better than 20 *db.*

Feeding a 1 kHz signal into the input, the output was set at ten volts. If we can believe the attenuator of my audio generator it took about 8 millivolts input to produce the ten volts output which seems about reasonable from past experience. This overall gain figure was produced with the 6SJ7 suppressor at ground potential. The negative potential on the suppressor was now increased in two volt steps and the effect on the output was noted and recorded for posterity in **Fig. 3**

At this juncture in the proceedings it was about time to decide what I was building and where it was going. An electronic

Suppressor Bias	Audio Output dB
± 0	± 0 (10 V. at 6J5 Plate)
− 2	− ½
− 4	− ¾
− 6	− 1¼
− 8	− 2
−10	− 2½
−12	− 3¾
−14	− 4½
−16	− 6
−18	− 9
−20	−13
−22	−21

Fig. 3. Control characteristics of the circuit of Fig. 2. Remember to include a switch in the battery circuit to increase battery life.

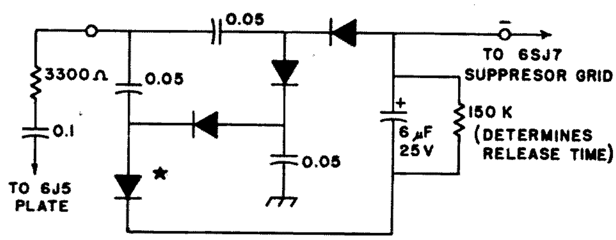

Fig. 4. An audio voltage-quadrupler circuit to develop the fedback control voltage in voltage compressor applications. It will offer a fast attack and slow decay.

primitive giving birth to a brain child can swing in many directions but the vine I grabbed led down the road marked "Audio Compressor". To quote from the Good Book, "You can derive a voltage from the audio signal and apply it to a suitable electrode in such a manner that the output signal will stay within proscribed limits when the input signal varies within reasonable limits". I felt that the suppressor grid would be a great "control electrode" and now all I had to do was derive a control voltage from the audio signal. If all the ideas I rejected to derive the control signal were detailed this article would rival *Gone Wih The Wind* in length. Naturally I realized the control signal needed would have to be dc in nature for simplicity and to avoid phase shift and feedback troubles associated with ac control signals. This led to the implication that I would need some sort of rectifier circuit but one with gain, if you please. The philosophy (a term meaning knowledge gained through hindsight) behind this decision was reached upon concluding the following.

A—the unit already had two tubes, and I am fond of even numbers.

B—I planned to pad the output of the little wonder down so it would feed proper level into existing mike gain stages, so high level signal voltages would not be available to me without tapping into the high level audio stages that followed the regular mike inputs. This was too cumbersome an approach so the control voltage had to be derived from the circuit as it now stood.

C—Referring to the chart of Suppressor Bias versus Audio output (**Fig. 3**) indicated a need for up to 20 volts of control signal.

Since the 6J5 very easily provided in excess of ten clean volts of signal, I decided to use one of the standard voltage multiplying rectifier circuits, winding up finally with a voltage quadrupler as shown in **Fig. 4**. The choice of the quadrupler was made so that the voltage needed could be obtained at the same time that a reasonable amount of isolation could be put between the 6J5 plate circuit and the rectifier circuit to avoid lousing up the audio because of varying loading produced by the rectifier over the ac cycle and to avoid feeding any generated audio harmonics produced by the rectifiers presence to the following aduio stages. The 3300 ohm resistor and the 0.1 mF blocking condenser feeding the audio from the 6J5 plate to the voltage quadrupler was determined experimentally to be a fair compromise between isolation as discussed and attaining the needed control voltage.

Fig. 4 shows the interesting fact that three of the voltage multipler condensers are small (0.05 mF) but that the output condenser is, by comparison, a fair sized electrolytic (6 mF) These values were chosen so that the quadrupler would quadruple, but the output voltage rate of decay would be rather completely under the control of the 150 K resistor shunted across the 6 mF output condenser.

Regretably, no epic dealing with an aduio compressor can fully bypass a small discussion of attack time (the speed at which the unit takes hold and compresses) and release or decay time (the time interval required to restore steady state circuit conditions when a good sized peak has become history). I candidly admit that I don't know the attack time of this little gem but blandly state that whatever it is, I must be doing

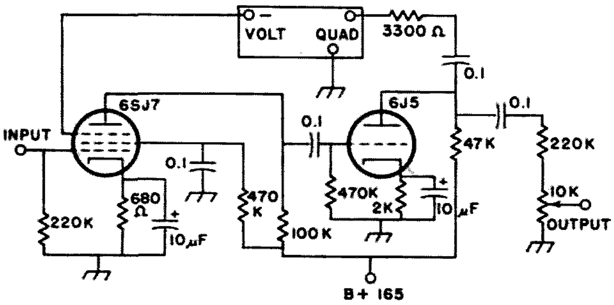

Fig. 5. The complete compressor circuit, with the quadrupler circuit replaced by the three-terminal box labeled "quad."

something right from the way it sounds in use.

The release time is easier to come by as you can readily time the decay of the control voltage by monitoring same with a VTVM and clocking the time of fall after hitting the input with a heavy "woof". The specified values give a release time of about 2½ seconds which works out well in practice for voice communication.

Fig. 5 gathers up all the pieces into the finished schematic of the practical functioning unit. For my own personal use (to feed my Gonset G-50) I used the output control circuit shown. There is no input gain control as the microphone used gives about 30 millivolts on close talking peaks. (a 100 millivolt signal will not overload the compressor or cause distortion). The audio to the G-50 is set by the output control on the compressor, which means that in normal use the compressor input is running wide open.

The Tabular data in **Fig. 6** is quite interesting. It shows the relationship between specific values of input signal, the resulting audio developed across the 6J5 plate load and the corresponding values of dc control voltage developed for application to the suppressor grid.

Notice that a change in input signal of 20 db (the range from 1 millivolt to 10 millivolts) gives an output change of about 13 db or a compression of about 7 db. If we push the input signal up to 30 millivolts (about 29.5 db over the reference 1 millivolt) then there is an effective compression of about 13 db. A 100 millivolt signal was applied experimentally with a recorded compression of some 21 db. The output as viewed on a scope was as clean as the signal produced by a 10 millivolt input signal.

Some parting thoughts in retrospect. Like most hams, my shack is not loaded with expensive test gear. The measuring equipment used was a Heath Audio VTVM, a standard 20,000 ohms per volt multimeter and an RCA Jr. Voltohmyst plus an ordinary 5 inch service type scope. Halfway through the first set of measurements I had the inspiration to see if the three meters involved agreed one with the other. Needless to say they did not and the work was stopped cold until they were shaped up. (How do your meters stack up for agreement?) Since my mill is an old one constructed before superlatives were invented I have nowhere stated that the subject of this article was "the best" or the living end.

As a matter of fact, after this project came to a satisfactory conclusion subsequent mental modifications suggested themselves and just beg for somebody to try them out. The thought was that the 6J5 could be replaced with a dual triode. One half would be nothing but the audio channel and the other half just the amplifier for the control voltage section. This would eliminate the RC isolation network across the present audio plate load and a point of possible distortion. A pot could be placed in the grid of the control amplifier triode to give easy control of compression if this were desired.

. . .W3KBM

Millivolts Input	Volts Out	Control Volts
1	0.9	1.9
2	1.5	4.0
3	2.1	5.5
4	2.6	6.8
5	3.1	8.0
6	3.5	9.2
7	3.9	10.1
8	4.2	11.0
9	4.4	11.5
10	4.6	12.0
15	5.6	14.5
20	6.2	16.0
25	6.5	17.0
30	6.8	17.5
35	6.9	18.0
40	7.1	18.2
45	7.2	19.0

Fig. 6. For an input voltage variation of 45:1, the output varies by 8:1. Use the control voltage readings to check the operation of your own circuit.

Putting the HW-12 on 160 Meters

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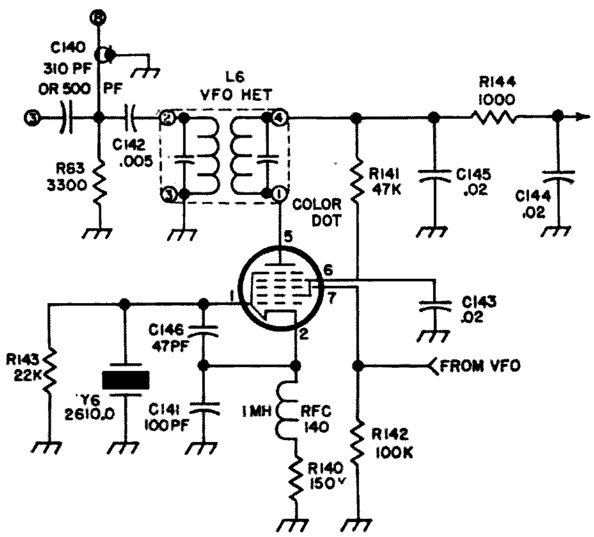

Carrier oscillator and heterodyne oscillator mixer

The SSB signal in the HW-12 is generated at 2.3 MHz and mixes with the 1.5-1.7 MHz VFO signal to get 3.8-4.0 MHz. After changing the VFO cathode follower, V14-6BE6 to a heterodyne oscillator mixer, the 1.5-1.7 MHz VFO mixes with the 2.6 MHz crystal oscillator. The output of the V14 Mixer is 4.1-4.3 MHz. When transmitting, the 2.3 MHz SSB signal is mixed with the 4.1-4.3 MHz in the V4-6AU6 xmtr mixer producing 1.8-2.0 MHz. When receiving, the incoming 1.8-2.0 MHz mixes with the 4.1-4.3 MHz from the V14 stage producing the *if* of 2.3 MHz. This conversion to 160 meters inverts the SSB signal. If we didn't change the crystal in the V11B-½12AT7 carrier oscillator stage, the converted HW-12 would respond only to upper sideband signals. This is easily remedied by changing the V11B stage crystal from 2306.7 kHz to 2303.3 kHz and the modified unit will respond to lower sideband (LSB) signals, both transmitting and receiving.

Transmitter driver and receiver rf

Modification of this part of the HW-12 only involves changing the L2-DRIVER GRID and L3-DRIVER PLATE coils. These coils also serve as *rf* stage coils in the receive mode. The coils are removed and modified, and then re-installed.

Transmitter pi-net

This portion of the modification affects only the transmitter section. The Pi-network tank variable C65, capacitors C66 and C67 (68 pf each), tank coil L4, and loading capacitor C77 are removed and their 160 meter equivalents are installed.

Whether you obtained your HW-12 new or used, the 160 meter modification should not be undertaken without reference to the Assembly Manual supplied with the kit. Not only is the manual helpful during the process of the modification, but it should be used to check the performance and alignment of the HW-12.

It is strongly suggested that time be taken before modification to measure and make a written record of voltages. Reference is particularly made to Figure 12 on page 52 and Figure 13 on page 53 of the HW-12 manual. Before the actual modification is started, make sure that the HW-12 performs normally on 3.8-4.0 MHz. This could very well save time and headaches later.

Parts needed for 160 meter modification

Besides the HW-12 and it's power supply, the following lists of parts is required for the 160 meter modification: (One of each required, unless otherwise specified)

2303.3 kHz crystal, Heath 404-196
80 Meter Driver Grid Coil, Heath 40-516
33 pF mica or ceramic capacitor
47 pF disc capacitor
56 pF, 4kv disc capacitor
100 pF disc capacitor

220 pF, 4kv disc capacitor
2000 pF (.002 mF), 500 volt mica capacitor
.02 mF disc capacitor
150-ohm, ½ watt, 10% resistor
1000-ohm, ½ watt, 10% resistor
22K, ½ watt, 10% resistor
1 mH *rf* choke
B&W Miniductor 3019 (see text)
Hammarlund MC-140-S transmitting variable
2610.0 kHz crystal, JAN Crystals (HC6/U holder)

Also, a small quantity of small size wire suitable for rewinding coils L2 and L3 is required. Sizes between #30 and #36 is suggested. The winding from an old 2.5 mH *rf* choke or a broadcast oscillator coil may be used. If it is decided that total coverage of the 160 meter band will not be used for transmitting, then the new 140 pF variable capacitor will not be required. The present final tank capacitor C65, 50-50 pF will cover at least one 25 kHz segment of the band. In this case, experimentation may be required for the exact values of the capacitors in parallel with the final tank variable to cover the desired 25 kHz segment of the 160 meter band.

It should be noted here that the new 80 meter Driver Grid Coil will be used for the Heterodyne Oscillator Mixer Coil L6 for 160 meter operation.

Modification

Carrier oscillator and heterodyne mixer

Remove the present carrier oscillator crystal Y1-2306.7 kHz and install the new crystal 2303.3 kHz. Remove the following parts from the V14-6BE6 VFO cathode follower: R140-1000, C141-310 pF, RFC-140-15 μH, and the jumper wire connecting V14-Pin 1 and Pin 7. Remove R141-47k and temporarily set aside for later installation.

Locate the new 80 meter driver grid coil (Heath 40-516) to be modified for use as L6 heterodyne oscillator mixer. Remove the coil from the shield can and then remove the 390 pF capacitor. Remove one end of the 100 pF capacitor and coil lead from pin 2. Remove the coil lead from pin 4 and solder it to pin 2. Now solder the free end of the 100 pF capacitor and the remaining coil lead to pin 4. Install a 33 pF capacitor between pin 2 and pin 3. Re-install the coil in the can and the install the completed L6 on the printed board between V13 and V14. Pin 1 of L6 goes to V14-pin 5.

See **Fig.** 1 for the installation of the parts in the het osc mixer. Double check to be sure of the proper location of each part before installing the part. Then install the part and check again for possible errors! It is easy to make errors, especially if you're not familiar with printed boards.

Locate C142-.005 on the printed board and remove the lead going to V14-pin 2. Connect this free end to L6- pin 2. Now locate C140-310 pF and remove the lead nearest V14. Connect the free end of coaxial cable, and R83-3300. Install the following parts: R140-150, R141-47K, R144-this capacitor to the junction of C142.005, 1000, R143-22k, C141-100 pF, C146-47 pF, C145.02, RFC140-1mH, and Y6-2610.0 kHz.

Driver coils L2 and L3

Remove L2 from the printed board and remove the shield can. Carefully add approximately 35 turns "Scramble-wound" to each winding. Wind over the present winding and away from the adjacent winding. Do not wind in the space between the primary and secondary windings. Check the windings with an ohmmeter and then re-install in the shield can noting the position of the color dot. Re-install L2 on the printed board.

Remove L3 from the printed board and remove the coil from it's can. Remove the windings, noting the pin connections. Wind a 6-turn link to pin 2 and pin 3 in the same location on the form as the original winding. Now wind approximately 85 turns over the link using the "scramble-winding" method and connect to pin 1 and pin 4. Check with an ohmmeter and then re-install in the shield can noting the color dot. Install L3 on the printed board.

Transmitter pi-net

Remove the following parts from the HW-12: 80 meter tank coil L4; final tank capacitors C65-Variable, C66-68 pF, C67-68 pF; and the loading capacitor C77-1000 pF.

Install the new C77-2000 pF capacitor in place of the old C77. Install the entire B&W 3019 Miniductor or wind 36½ turns of No. 16 enamel closewound on a 1¼-inch

diameter form 3-inches long. The winding will take up about 2-inches. Install the variable capacitor at the final tune location on the front panel. Install the fixed capacitors from the hot side of the variable capacitor to ground. The fixed capacitors are 220 pF and 56 pF at 4kv. Solder a lead from the top of coil L4 to the hot side of the tank capacitor combination C65-C66-C67.

Alignment

Follow the procedure outlined in the HW-12 manual for the alignment of the VFO dial calibration, bias setting, *if* amplifier adjustment, and balanced modulator adjustment.

Het OSC mixer alignment

1. With the VFO dial set to 1.8 (3.8), turn the function switch to the tune position and the meter switch to tune operate.

2. Adjust the upper slug of coil L6 for maximum output.

3. Set the VFO dial for 2.0 (4.) and adjust the bottom slug of L6 for maximum output.

4. Repeat steps 1, 2, and 3. If results are not satisfactory, try adjusting the upper slug at 2.0 and the bottom slug at 1.8

Driver alignment

1. Adjust the upper slug of driver grid coil L2 for maximum output at 1.8.

2. Adjust the bottom slug of L2 for maximum output at 2.0.

3. Adjust the slug of Driver plate coil L3 for maximum output at 1.9.

4. Repeat the steps as necessary for the desired results. If flat response across the entire band is not obtainable, then try for response across the desired 100 kHz portion of the band. For example: adjust one slug of L2 at 1.8, the other slug of L2 at 1.9. Adjust L3 at 1.85.

Now go back to L6 and adjust if necessary for response across the desired portion of the band.

Gratifying reports were received on 160 meters saying that the rig sound every bit as good as an unmodified unit on 75 meters.

. . . W8FGB

Tuning a Parasitic Beam

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Most antenna construction articles don't go into much detail on making tuning adjustments. If you are not familiar with the tuning details, it can take twice as long to tune the beam as it took to build it.

In spite of all the elaborate antenna designs which have been developed in recent years, the old grounded "Plumber's Delight" parasitic beam remains one of the most popular antennas for HF and VHF bands. Reasonable gain can be achieved with two or three element beams using .1 to .15 spacing of elements. Construction is easy and materials for building such a beam are readily available almost anywhere. It can be made rugged to withstand weather conditions and normally won't require any servicing once it is properly tuned and installed. Finally, with few exceptions, it provides much more satisfactory performance than antennas made of wire elements.

Among other advantages, we should also add that it is really easy to tune, both for forward gain and front to back, if you know the procedure.

We won't deal with construction details here, since those are available in handbooks, antenna handbooks, and in numerous articles which have appeared in ham magazines over the past years. Typically, these articles devote much time to construction of the beam itself, including the usual Gamma matching section, but only passing mention is made of the details of tuning adjusting for maximum performance.

To the experienced antenna builder, this article will be of little value. However, for the Novice or new ham, tuning a beam can be a frustrating experience which requires an inordinate amount of time, sweat, and even tears. Many a beam building project has been abandoned at this point, or has simply been put into service with less than optimum performance. I repeat . . . . tuning a beam is easy.

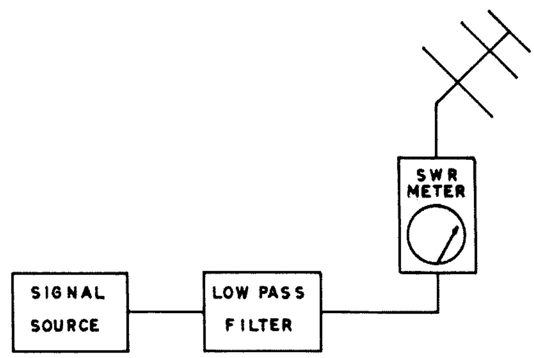


Fig. 1. Equipment diagram for driven element matching adjustments.

This article will deal with the single band, Gamma matched beam, and will show you how the beam can be tuned easily and quickly, to give you the best performance. After all, you are going to devote a good deal of time to constructing the beam, now, let's get the most out of it. Don't rush! There are certain pieces of equipment you will need to do a first class job. If you don't own them, borrow them. It is also helpful to have one other person to assist, but it can be done alone.

First, let me make one point clear. It is virtually impossible to achieve maximum forward gain and maximum front to back ratio on the same beam. The forward gain is determined primarily by the element spacing and the efficiency of the driven element. The front to back is determined by the length of directors and reflectors, although both are important in the case of forward gain. In nearly all cases a compromise must be reached if one factor is not to be sacrificed. However, the following procedures will usually give the best results without losing too much on either forward gain or front to back.

Test setup for matching adjustments

Once the beam has been constructed ac-

cording to the dimensions outlined in an article or antenna manual, the next step is to adjust the matching section on the driven element of the beam for correct matching to the transmission line. It is desirable to make these adjustments with the beam in its final location, but since this is usually a physical impossibility, the idea is to get it as far above ground as is possible. Keep it as far away from obstructions, especially large metal surfaces, as you can. For HF beams, a tall stepladder will suffice.

Correct matching conditions are indicated by obtaining the lowest SWR reading possible on the coax transmission line. As shown in **Fig. 1.**, the SWR meter should be located as close as possible to the antenna end, not the transmitter end of the transmission line. There are two reasons for this. First of all, if the transmission line has any appreciable losses, a false reading will occur at the transmitter site and usually will appear better than the actual situation at the feed point of the antenna. Secondly, you will want to be in a position to observe the readings on the SWR meter as you are making the adjustments in the matching device. Therefore, you will need a SWR indicator of one type or another. This can vary from a simple home-brew "Monimatch" which will cost pennies to construct, to an elaborate commercial Wattmeter which will cost more than pennies. Since we are concerned with the power getting to the antenna and the amount being reflected back to the transmitter, any reliable SWR indicator is acceptable.

An absolute minimum of connectors should be used in the coax line, including those used at the SWR meter. While new connectors usually don't introduce significant loss, each one is a potential source of future problems due to corrosion, etc. There rarely is a need for a connector at the antenna feed point, and a soldered (not twisted) pigtail connection is best. Soldered pigtail connections should definitely be used during adjustments.

The transmitter, or other signal source, must first be properly matched to the transmission line. A dummy load at the antenna end, with the SWR bridge at the transmitter end will confirm this match. Once the transmitter is tuned up with the dummy load, these adjustments should not be changed throughout the entire tuning procedure. **Fig. 1.** shows a low pass filter at the transmitter end because harmonics fed to the antenna will cause false readings. Most present day transmitters have harmonic content low enough to prevent any problems, but some harmonics are always present and unless you use an expensive signal generator as the power source, the use of a low pass filter is a necessity. Most of the less expensive signal generators have, at best, a broadly tuned output circuit and the harmonic content can be high.

Now what about the accuracy of the SWR bridge? If you were able to achieve close to a 1:1 ratio with the Dummy load at the antenna and the SWR indicator at the transmitter, it is reasonable to assume it is correctly calibrated.

Adjusting the matching section

Most beam of this type use the Gamma matching section shown in **Fig. 2A,** although the Delta match shown in **Fig. 2B** does have some advantages, and is still used in some construction. There are several ways to explain the action of the Gamma match. One concept is that the loop 1-2-3-4 induces a voltage in antenna section 1-2 which is then coupled to the rest of the driven element. Since the loop 1-2-3-4 is not large enough to be resonant, its inductive reactance must be cancelled out by the series capacitor in leg 3-4. As long as legs 1-2 and 3-4 are reasonably closely spaced, they act similar to a transmission line, and no radiation occurs from the matching section.

Generally the dimensions chosen for the

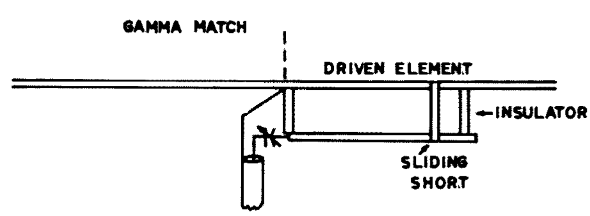
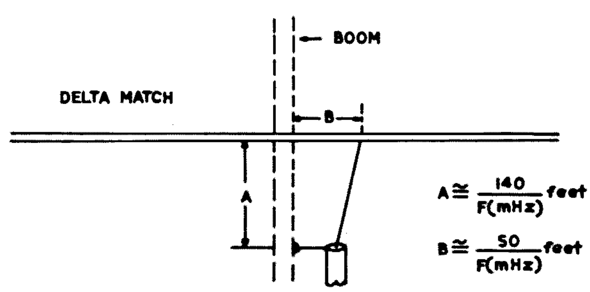


Fig. 2. (A) Basic form of Gamma match and (B) Delta match.



Gamma section are such that its length is from 1/10 to 1/16 of a wavelength and the spacing between sections is 1/30 to 1/60 of a wavelength with the maximum value of the series capacitor in pF being 7 times the wavelength in meters.

The adjustment now depends upon whether you have built the beam from the dimensions given in a construction article in a magazine or manual, or whether it is an individual creation. In the first case, assuming a series capacitor has been used in the Gamma match, the procedure is as follows.

1. Using a transmitter or rf signal generator, excite the antenna with sufficient power to obtain a reasonable indication on the SWR meter.
2. Adjust the sliding short for minimum SWR, or at least a decrease in SWR reading.
3. Adjust the series capacitor for minimum SWR reading.
4. Go back and forth between steps 2 and 3 to get minimum SWR indication. The SWR *must* go through a rise-dip-rise-dip sequence.
5. After the minimum possible SWR indication has been obtained, adjust the driven element length (try lengthening first for a further reduction in SWR indication. This is fairly critical and on a HF beam should not be more than a few inches in length. Remember, at this point the reflector and director(s) should not be adjusted.
6. Finally, double check the final SWR reading by going through the calibrate procedures for the type of SWR meter used.

In the case of an individually designed beam, where we assume dimensions are pretty close to "text book" specifications, (both spacing and element lengths) it is a good idea to check the frequency resonance of the driven element first. Where there is a difference in element diameter, the resonant frequency of the driven element may be far from the expected value. The Gamma match section may be connected in some temporary way and the signal source frequency varied to check to see that a broad SWR dip occurs near the desired frequency. Here we find a grid-dip meter to be an invaluable aid. With the feedline disconnected and a few inches of wire attached to the feed point of the driven element and loosely coiled around the grid-dip meter coil, a pronounced dip will occur at the resonant frequency of the driven element. Be careful here, because other minor dips may occur. There is no point in continuing with the matching section adjustments until the resonant frequency of the driven element is established. Once this has been determined, the same steps should be followed as outlined for the other version.

If you want to eliminate the difficulties usually encountered by the use of a series capacitor in the Gamma leg, this too can be accomplished simply. Instead of using step 3 in the sequence, vary either the spacing between the Gamma section and the driven element, or vary the diameter of the Gamma section. This requires the patience of a Saint, and the SWR may never reach the desired 1:1. However, if you get close (1.2 or 1.3:1) it is worthwhile to accept the adjustment and gain the advantage of not having another component, way up there on the tower or mast, which could ultimately break down and cause problems.

The Delta match is appealing because of its simplicity, but it can prove more difficult to adjust. It is possible to simply use the center conductor of the transmission line on the Delta match leg. The dimensions shown in **Fig. 2B** should be considered to be approximate and merely as a crude starting point. Once the driven element has been adjusted for resonant frequency, the adjustment of the Delta match follows much the same procedure as that for the Gamma match. Instead of adjusting matching section length and spacing, however, dimension A and B of **Fig. 2B** are adjusted for minimum SWR. The procedure is time consuming and tedious, however, and spare coaxial cable should be allowed in the event that, on the first try, too much of the center conductor is cut away. On the other hand, the end result is an extremely simple, highly reliable feed system.

Adjusting the parasitic elements

These adjustments don't necessarily have to be made. Most beams, when cut to "text book" dimensions, will perform well. However, there is always the goal of producing the last db of possible performance from a beam. If properly constructed in the same manner, and of the same materials, there is every likelihood that the proper frequency relationship will be retained. The reflector should be 5% longer than the driven ele-

ment, and the director should be 4% shorter. Each additional director should be made successively 4% shorter until the third director element when the length remains constant for any additional elements.

Here we get into the compromise situation between forward gain and front to back ratio. This, of course, depends on the individual's wishes in the matter. In some areas of the country the front to back is less important than in others. Forward gain is the prime factor. In others, the curtain of signals coming in from the back of the beam, may make the difference in hearing a DX station and not hearing him. Having lived in Hawaii, Colorado, and now the East Coast, there are three sets of circumstances and my beam tuning has changed with the circumstances.

In Hawaii, there was little QRM from the West, but an iron curtain of Western U.S. stations to the East. There, forward gain was important. In Colorado, where QRM came from both East and West, front to back ratio was important if I wanted to hear the incoming signals. Here in the East, I find a compromise situation must be achieved. The individual will have to make his own decision as to this approach to efficiency. In many cases, the loss of a db or two in forward gain is worth the added attentuation of signals coming in off the back of the beam.

Tuning for maximum forward gain

A field strength meter is placed at least two full wavelengths directly in front of the director's path. A short horizontal dipole connected to the field strength meter is best, but a vertical antenna will work reasonably well in these measurements. The beam is excited and a reading taken. Here is where the second person can be utilized to take the readings. However, I have found good results using a pair of good binoculars or even a telescope to make the readings alone. A telescope allows readings from a greater distance, but at two wavelengths, binoculars will do well. The meter should be isolated from reflecting surfaces and should not be held by another person. After an initial setting is obtained, the meter adjustments should not be changed. The beam's reflector and/or directors should slowly be changed in length for maximum indication on the meter. These adjustments will be

broad, but should show a definite rise and fall in the meter reading with changes in length. Continue this process until maximum field strength readings are obtained.

Tuning for maximum front to back ratio

To achieve maximum front to back ratio, follow the same procedures described for forward gain, but have the reflector element facing the field strength meter. The reflector element should be adjusted for a minimum dip on the field strength meter. This dip should be quite sharp as small changes are made on the reflector length. The director should be then adjusted for a null on the field strength indicator. This adjustment will be much broader than that of the reflector.

A compromise between forward gain and front to back ratio can only be made with a three element (or larger) beam, and requires a combination of the previous procedures. Basically, the directors are first adjusted for maximum forward gain (first adjusting the director nearest the driven element) then the beam is turned 180° and the reflector is adjusted for minimum field strength reading. The director(s) is not readjusted.

In all these adjustments, low power should be used not only to reduce the physical problem of *rf* "tingles" and/or possible burns, but to reduce the QRM radiated on the given band. Use only the amount of power required to produce adequate readings. If working alone, it would be wise to locate the transmitter or signal source where it can be kept under control at all times.

After all these adjustments have been made, it is a good idea to check the driven element SWR again, especially if the transmission line has been removed from the beam at any time. Unless the parasitic elements have been changed drastically, there should be no significant change in SWR. It may have improved somewhat in the process. However, a final check is in order before removing the test equipment and permanently installing the beam at the top of the tower.

One final word. I have found it to be more successful in the tuning of the driven element to remove it from the beam and isolate it for the initial tuning. Make believe you have a dipole antenna and tune it as if it were the only antenna you were going to use. Then reassemble it on the boom and make the other tests. This is minor, I assure you, but if you are looking for that last db of efficiency, it can mean a JND (just noticeable difference).

. . . W1EMV

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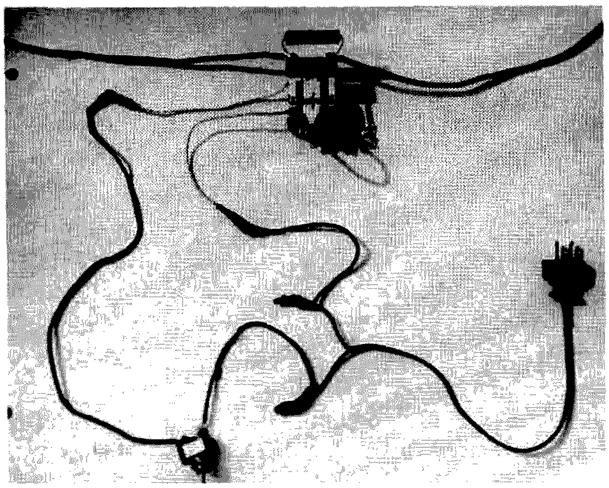
Does Your Linear Need Help?



Mockup of the modification. Plate supply ground return contains a 5000 ohm resistor, shunted by the normally closed relay contacts.

Has your linear started blowing fuses when you turn the plate switch on to tune up? Or maybe the mercury-vapor tubes inside are frequently flashing a bright bluish-purple? Could be you have heard a disturbing "thump" from the power transformer as well!

You may know about a cold pill to cure wheezing, sneezing, and assorted miseries, but would you believe one simple modification to your rig can end fuse blowing, tube flashing, and transformer thumping all at once?

These troubles may start as you turn on the plate switch of the linear if the sine wave of the alternating supply is almost to a peak. This causes the rectifiers to send an enormous inrush of direct current to the starved filter capacitors. Even if a fuse doesn't blow, this surge won't do the mercury vapor tubes a bit of good. And the jarring thump of the transformer may shake you up so much that you miss that choice DX station who just called CQ on the frequency where you're listening.

The filter in my factory-built linear consisted of six 100 μF capacitors in series with equalizing resistors across each one. I merely opened the low potential lead from the grounded center-tap of the plate transformer and inserted a 5000 ohm, 20 watt resistor in series. Then I connected a relay with normally-closed contacts in parallel with the resistor with a jumper to short circuit it. The primary coil of the relay is operated by a toggle switch mounted on the front panel. The 120 volts ac for this is picked up where the line enters the cabinet and is protected by the unit fuse, of course. The 5000 ohm resistor is permanently wired in the circuit. Whether the relay is energized or not, there is no time when the center-tap of the plate power transformer is open. Be sure your relay is wired in this manner.

When the fialment switch is closed, the mercury vapors heat; then, the modification switch is closed, and the relay removes the short circuit from the 5000 ohm resistor. When plate power is turned on, this extra resistance allows the filter capacitors to charge more slowly. You will notice a momentary brightening of the mercury vapor tubes but no flash, no thump, and no blown fuse.

After opening the modification switch, you're all set to call and work that DX station, so get after it!

. . .W9VEY

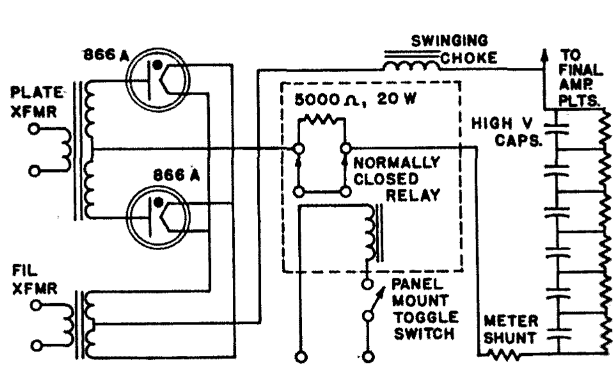


Fig. 1. Modification shown within dashed lines prevents quick inrush of charging current to capacitors. This reduces strain on fuses and mercury vapor rectifiers. Also good for semi-conductor rectifiers.

Some Thoughts on Voltage Control

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Canada

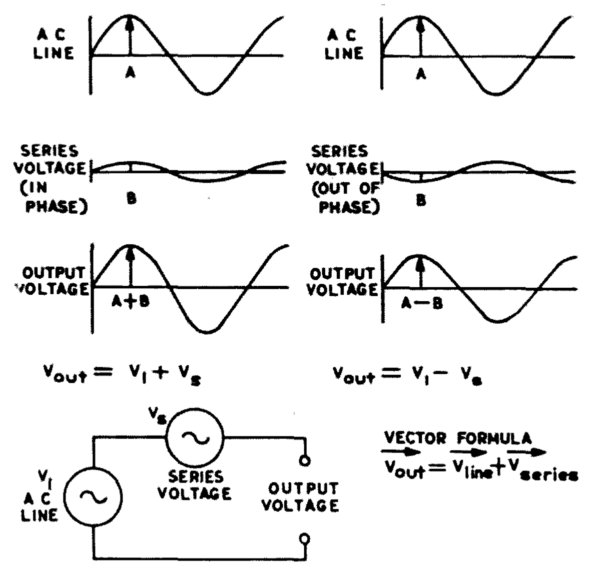


Fig. 1 Boost/Buck system of voltage control. V1 and Vs must be of same frequency sine-wave output to preserve.

An earlier article[1] by Jim Kyle, concerning adjustment of an ac line voltage by the "Boost/Buck" system, prompted some further thought and experimentation along a similar line. Although the underlying theory of the system described by Kyle simply involves vectorial addition of two ac voltages of the same frequency, there is some tendency to confuse it with the system of **Fig. 2.** The boost-buck system explained in **Fig. 1** is often used in small line voltage regulators for field day use, the series voltage being derived from a step-down transformer whose primary is paralleled with the ac line voltage. **Fig. 3** shows such a system. Since the phase shift across the transformer is 180 degrees (or nearly so) the series voltage can be made to boost or to buck the input voltage with a reversal of either the primary or secondary transformer leads. For the in-phase case the vectorial addition of **Fig. 1** becomes simple addition; and for the out-of-phase case the resultant voltage is the difference of the other two.

The system illustrated in **Fig. 2** involves changes in the magnetic flux densities of the transformer core. This method may be used to vary the output voltage of a dc supply of the transformer type. Basically then, if a secondary winding is connected with the transformer primary in "series-aiding" the flux density due to the primary current tends to be greater. This translates into increased voltage induced in any other windings. Conversely, the flux density would decrease should the two windings be connected in a "series-opposing" fashion. **Fig. 5** diagrams a dc power supply which employs this technique.

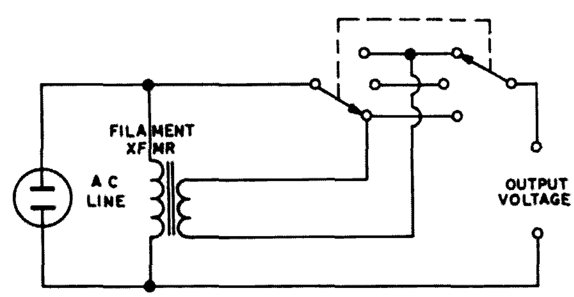


Fig. 3. Practical "Boost/Buck" manual voltage controller.

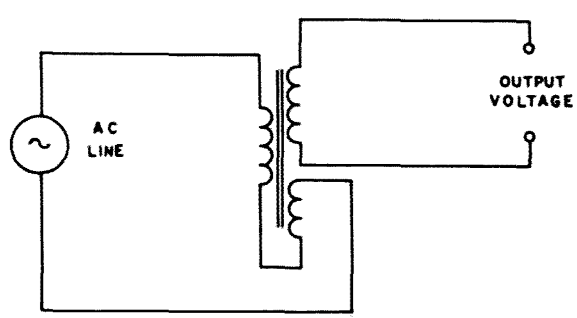


Fig. 2. The "Series-Aiding/Series-Opposing" system.

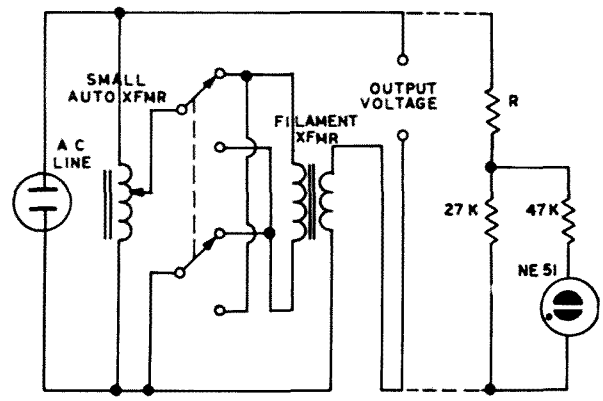
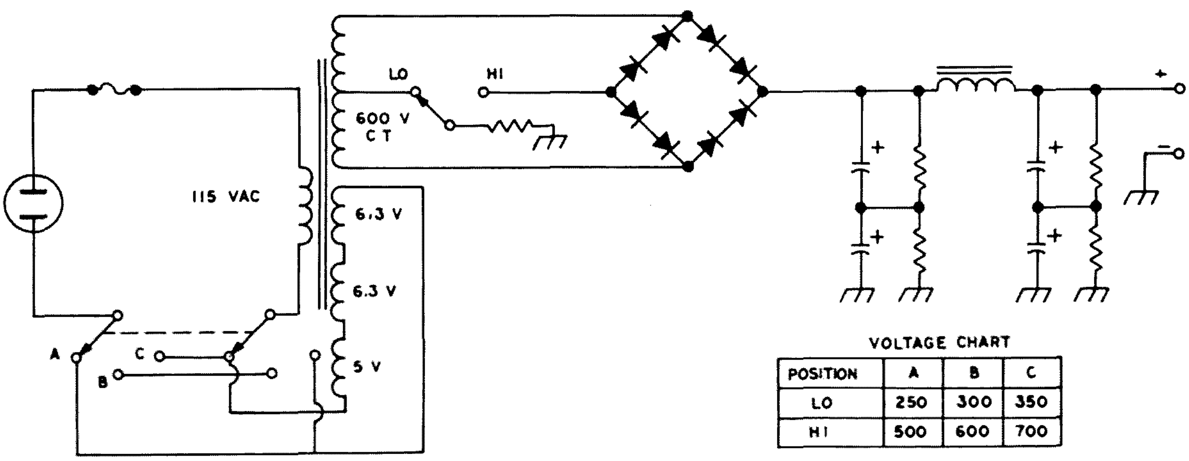


Fig. 4. Variable "Boost/Buck" system with neon bulb indicator. Adjust R so that bulb fires at desired voltage setting.

These methods of voltage control are very desirable in cases where load requirements are variable. They are much preferable to a series dropping resistor since, not only can they adjust up or down, they consume very little real power and only slightly affect voltage regulation.

Reference

1 *Kyle, An AC Voltbox, 73, October 1966.*



POSITION	A	B	C
LO	250	300	350
HI	500	600	700

Fig. 5. Flexible dc plate supply using a TV power transformer with multiple filament windings.

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Solid State Monitoring

Or . . . Here's Looking at You!

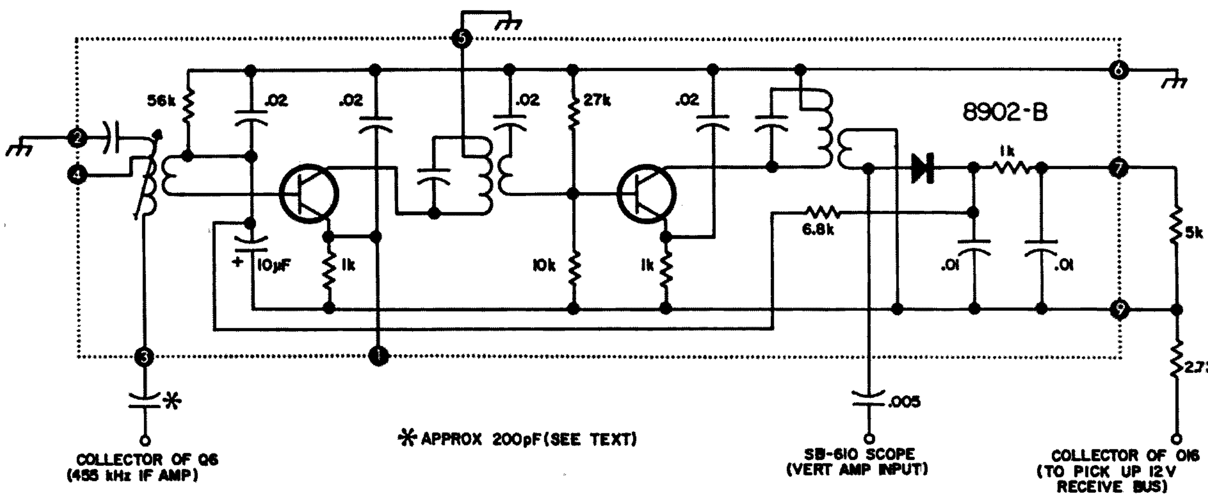

Fig. 1. The pre-wired circuit of The module.

The Heathkit Model SB-610 Monitor Scope is a convenient instrument for use with an amateur radio station to monitor "on-the-air" signals. It can also be used to monitor radio signals from other stations when used in conjunction with a receiver . . . or so says the Heath instrument manual. And the statement is certainly true; also, as easily accomplished as the manual indicates when the application is to a vacuum tube receiver's *if* strip. Try it with a solid state receiver or transceiver, and the cheese gets a little more binding, as they say!

Conventionally, receiver monitoring connections are made to either the grid or plate circuit of the last *if* stage in the receiver, using the smallest value of coupling capacitor that will give adequate pattern height. In this manner a portion of the signal is sampled and coupled through the vertical input jack of the scope to the vertical amplifier. In the cost of the SB-610 this is a vacuum tube stage employing a 6EW6. The input resistance is 100k ohms.

When the application is to a transistorized *if* stage with its lower signal level and lower impedance, the resultant picture on the scope is totally unsatisfactory. If the attempted pick up is at 455 kHz *if*, a very simple and inexpensive solution lies at hand . . . a tiny transistorized *if* module known as the 8902-B, put out by the Miller coil people. For only $3.75 this little gem will provide 55 dB gain. Bandwidth is 8kHz at 6 dB; dc requirements only 2 mils at 6 volts.

With various manufacturers hinting at new solid state receivers or transceivers on the horizon, the 8902-B may be a very handy gadget to know about. Right now any owner of an SBE 34 or 33 transceiver who has ever attempted to monitor received signals on an SB-610 has quickly found out it just won't work . . . at least, not without modification. But the Miller 8902-B module provides a made to order solution.

Fig. I illustrates the pre-wired circuit of the module and a typical application between a transistorized *if* stage and the Heath Monitor Scope, using the SB-34 as an example. The small size of the 8902-B lends itself beautifully to mounting under the circuit board at the left rear corner of the chassis. (See **Fig 2** for a simple method of mounting via a lightweight metal mount-

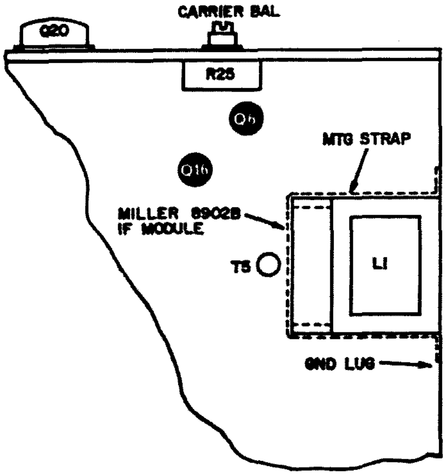

Fig. 2. Simple Mounting Method.

ing strap clamped under the existing screwed in mounting feet for audio choke L-1) This will place the module in colse proximity to the pick-up point for *if* input as well as for dc power.

Coupling to the receiver circuit is accomplished at a point under the circuit board where the collector of the 456 kHz *if* amplifier Q-6 is connected to the high side of the receive path input winding of 456 kHz if coupling transformer T-2. Fairly heavy coupling (200 $\mu\mu$F or so) is required if maximum picture height is desired. It is possible to obtain this however, and compenusate for the detuning eect by retuning the slug of T-2 for maximum audio signal by ear . . . on a received monitored signal . . . or maximum transmitter output on a two tone test. When you're all through make sure any retuning of T-2 has not upset the corret setting of the carrier balance pot.

Many of today's transceivers (whether solid state or not) make use of bilateral stages that must do double duty, functioning on both receive and transmit path. This must be taken into consideration when attempting to use the Heathkit Monitor Scope. A bilateral *if* stage would continue to provide a signal on transmit. This would be applied to the vertical amplifier of the SB-610, superimposing a signal on top of the energy being picked up from your own transmitter for the monitoring of your own *rf* output.

Here again the 8902-B strip provides an easy does it out when applied to any transceiver with a keyed voltage bus on receive. The solid state switching of an SBE-33 or 34 does this by providing a plus 12 volt bus from the collector of switching transistor Q-16 in the receive mode. The same point is at ground potential during transit, effectively killing the passage of a 456 kHz *if* signal through the little Miller module.

Terminal 7 of the 8902-B normally suplis audio output where required in receiver building block type applications. For the monitoring application described in this article the unit is easily modified as indicated by the *rf* output lead shown in **Fig. 2.** A new terminal is created for this lead by bringing out a small wire from the input side of the diode. This may be threaded through a small vacant hole that exists in the phenolic baseboard of the module between active terminals 7 and 9.

Go ahead . . . try it. You'll add new meaning to the words, "Here's looking at you"!

. . . W6JJD

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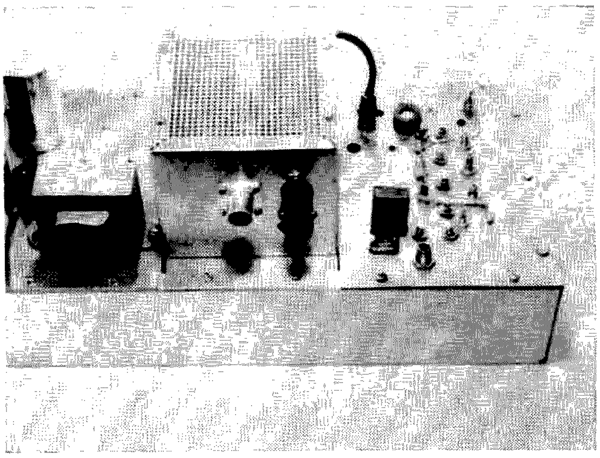
The 2 Meter Transistor Transmitter Plus One

With the present popularity of both 6M and 2M FM, the cry for more up to date equipment has been heard. Here, in part, is the answer to that cry—a transistor 2 meter FM transmitter which meets all the desired requirements: narrow band, size, efficiency, power, and most of all reliability.

The basic circuit was more or less a copy of the 250 mw transmitter circuit which appeared in the T. I. Dalcom Booklet. Unfortunately, 250 mw is not of much use, that is unless you want a walkie talkie. With the addition of the 2N3866, a power of 2.5 watts can be obtained without too much trouble. The 2.5 watts can be used to drive most any tube circuits in the 100 watts range.



The circuit

Basically the circuit is an oscillator followed by a phase modulator, 3 triplers and 4 class C amplifier stages. The power supplies are simple series regulators from a common source and a standard full wave rectifier for the high voltage.

The oscillator Q1 is a Pierce with L1 tuned to the oscillator frequency. The 33 pF capacitor from the base to ground can be variable for frequency adjustment. Some frequency pulling was noted in tuning LI.

The phase modulator is fairly straight forward. Here an ordinary AM signal is combined with a somewhat larger unmodulated carrier which is shifted in phase by 90° from the phase of the carrier in the AM signal. The resultant signal then varies in phase with the modulation. The 6.8 pF capacitor produces the required 90° phase shift while Q2 acts as the control device. The two signals are added vectorially at the collector of Q2. About 2.0 volts RMS is all that is required to give ± 5 KHz deviation at 144 MHz.

The next three stages of Q3, Q4, and Q5 are triplers which are tuned to 16 MHz, 48 MHz, and 144 MHz respectively. Q5 has an output of only a few mW which is then coupled into Q6. The output of Q6, which is a class C amplifier, is coupled by way of a 15 pF capacitor and the two 270 ohm resistors 1000 pF capacitors to Q7 and Q8. These stages have separate bias resistor and emitter resistor to help compensate for any unbalance in the dc and beta between the two units. The output here is around 250 mW to 300 mW which is coupled through the 25 pF variable capacitor to the base of the 2N3866. The 2N3866 is tuned by way of the 30 pF variable, L7, the six inches of RG-58 and L 8.

The final is a 6146 which like the other stages is operated class C. Neutralization is accomplished by use of the modified Z235. Series tuned circuits are used in the grid and the plate circuits for maximum efficiency. The output is around 35 watts with 400 volts on the plate.

The power supply shown in **Fig. 2** for the transistor stage is full wave bridge and a simple series regulator using surplus 2N1050's or any other NPN med. power transistor. The plus 28 volts supply used

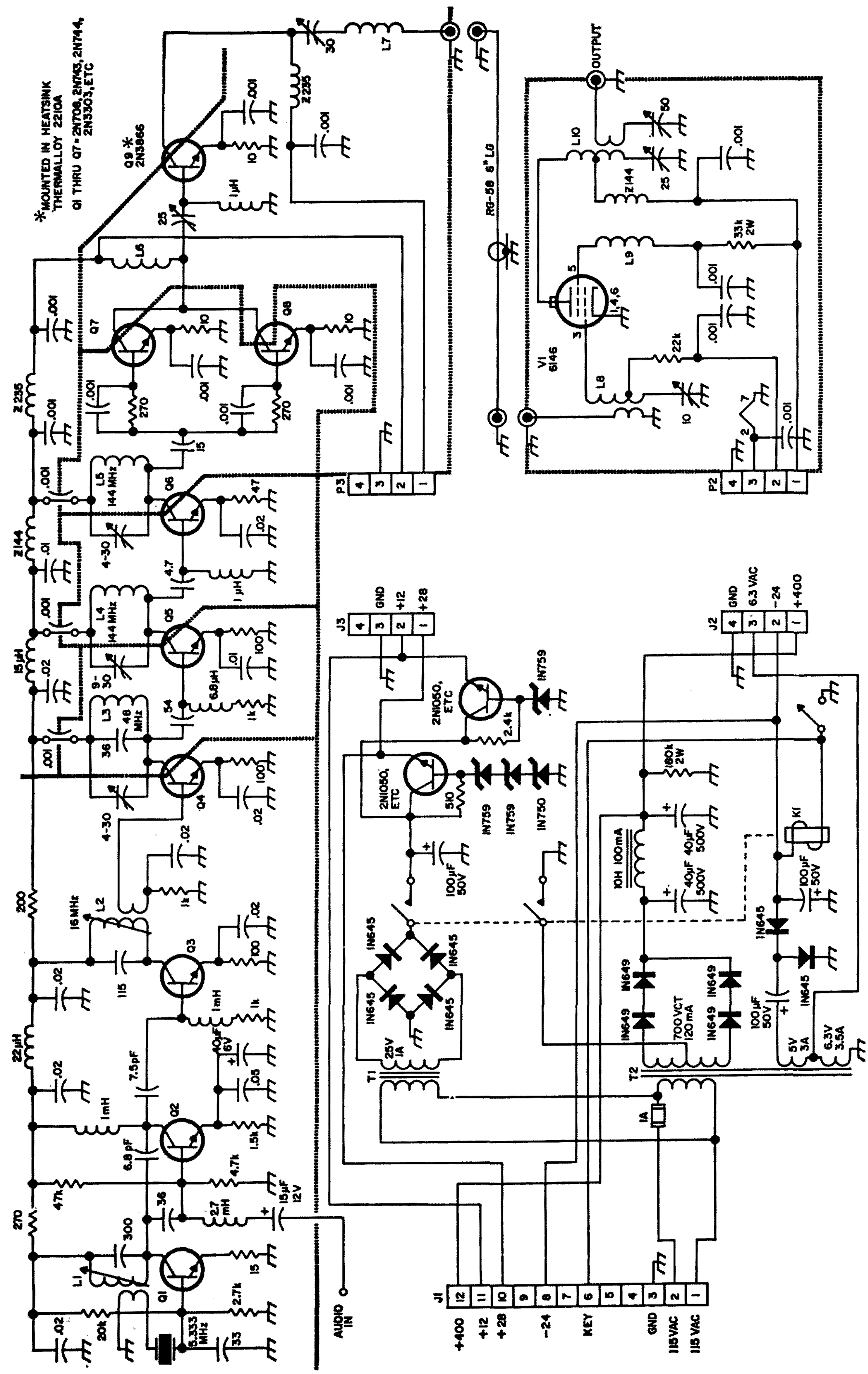


Fig. 1. Schematic diagram for the "Two meter transmitter plus one" with power supply for the transistor stage.

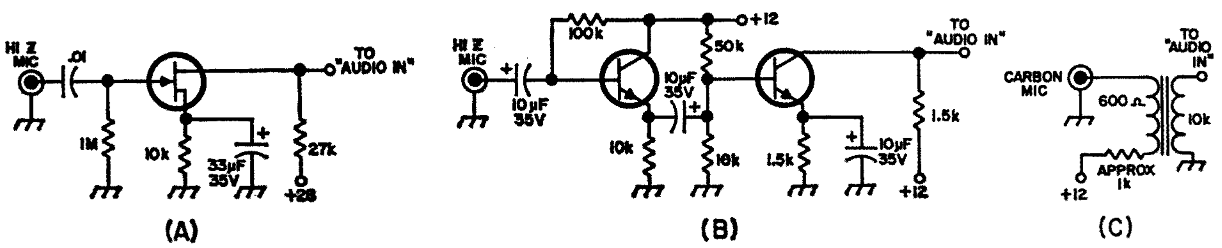


Fig. 2. Three audio preamp methods depending on the type of mike used. C is for a carbon mike, and either A or B may be used for a crystal mike.

three zeners in series for a reference but one 28 volt zener could be used. The output voltage is: zener voltage–0.6 volt. The supply for the 6146 is a standard full wave with a π filter using two 40 mfd capacitors and a 10 Henry choke. The relay voltage and the bias is obtained putting the 5 and 6 volt winding on the transformer and half wave voltage doubler in series. The fixed bias is not really high enough to hold the tube but is better than none at all. The relay K1 is used to key both the high voltage and low voltage to the transmitter.

Construction

As can be seen in the photo, no effort was made to make the transmitter in any way compact. In fact, as a general rule, the layout has quite a bit of room. The transmitter exciter is constructed on a 5 x 7 inch sheet of brass. The reason for using brass is mainly because it is easy to work with in mounting components and in making the shields. Each stage, with the exception of the oscillator, phase modulator, and the first tripler, is constructed in its own compartment. The use of ¼ watt resistor, miniature chokes, and tantalum capacitor make the construction fairly roomy.

As a general rule, no parts are critical, except in the last few stages and here only the chokes and the coupling capacitor values, but I guess that doesn't leave much! The shields are used not only as shields but also to give locations to make *good short ground* connectons. Johnson miniature variables capacitors (160-130) were used throughout except in the base and collector of Q9. Here the base and collector capacitors are midget mica trimmers (ARCO 422 40 pF to 4 pF). The output is coupled by way of a six inch piece of RG-58. Here, and only here, is the only critical point in the construction of the unit. If the coax is longer, the ARCO Trimmer in the collector of Q9 may have to be a bit larger or L7 smaller. If the final is not going to be used, the circuit shown in **Fig. 4** can be used to match a 50 ohm load. As stated before the 33 pF capacitor from the base of Q1 to ground can be variable so that the frequency can be moved somewhat. The audio is fed into the transmitter by way of a phone jack. There is no audio preamp shown on the circuit in **Fig. 1** because it was unknown what type of mike would be used. There are three methods shown in **Fig. 2A, B,** and **C** any of which will work equally well. As to the transistors used, the 2N708 were used here, but others were tried and worked about as well. The 2N708 can be bought surplus for 2/$1 from Poly Paks or new for only $1.32. The "silect" version of the 2N708 is the TIS45 which sells for around $.60 new. The best transistor tried was the 2N2369 costing $2.40.

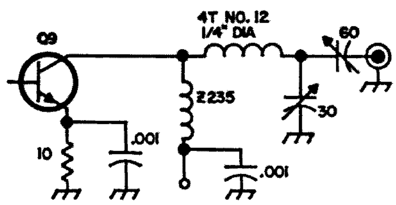


Fig. 3. If the final is not going to be used, this circuit can be used to match a 50 ohm load.

But the "silect" TIS48 costs only $.64. All things being equal the 2N708/TIS45 seems to be the best for my money. The 2N3866 is made by RCA and, to the best of my knowledge, it can not be bought surplus but is only $5.00 new. As for the transistors used in the audio preamplifier in **Fig. 3B** most any NPN would work with little or no difference at all. The FET amplifier in **Fig. 3A** has some advantage and may be preferred, here again most of the bargain FET's will work fine.

The 6146 final is constructed on a 4 x 7 inch plate and the 6146 is enclosed in a 4 x 4 inch box. The capacitor used in the

grid circuit is a Johnson Miniature (160-104). The grid coil is series tuned with the link tightly wound over the grid coil. The plate circuit is also tuned with the one turn link in the center of the coil. The transistor exciter and the 6146 final both have 4 pin male Jones connectors mounted on them so each can be removed with ease.

The power supply is mounted on an 8 x 7 inch plate. The low voltage regulator is constructed on a 3 x 2 inch piece of Vector Board. The transistor used in the low voltage regulator is any NPN medium power transistor with collector to emitter breakdown voltage of 50 volts or more. A 2N1050 was used here but any of the 2N1048, 49, 50 can be bought for a dollar or so surplus. The three units are mounted on a 7 x 17 inch chassis and a 12 pin male Jones connector is used for voltage output and keying.

Tune up

With the use of a GDO and rf indicator, such as a wattmeter, or wavemeter, the tune up is pretty simple. *Never operate the transistor exciter without a load.* If it is operated without a load the 2N3866 will be damaged. First tune L1 until the oscillator starts and shows maximum output on a wavemeter or a receiver. Next tune L2 through L9 for max rf output into the wattmeter or load. These will have to be repeaked a couple of times. The bias to the 6146 can be *removed* and a 0-5 mA meter can be used from the 22K resistor to ground to indicate grid current. With all stages peaked the grid current should be around 2.5 to 3.0 mA. The plate current should be around 150 mA at 400 volts. The screen voltage should be approximately 190 volts. The 28 volt current is around 125 mA; the 12 volt current is around 100 mA. The output was measured to be 36 watts but will vary somewhat. No provisions were made for an audio preamplifier. If a carbon mike is used, use **Fig 3C**; and **Fig. 3A** or **B** for a crystal or ceramic mike. The unit here is being used on 143.950 MHz MARS.

. . . K5WOR

The Yasme World-Wide DX-peditions

The YASME Foundation
P.O. Box 2025
Castro Valley, California

YASME II, symbolically displaying "DX - 73" on its main sail.

The YASME World-Wide DX-peditions have given many a ham his first contact with a rare country during the last decade and a half of amateur radio. To some amateurs YASME means a ship; to others it stands for a mysterious group of rich amateurs; but to the majority of the amateurs of the world, it stands for DX. Everyone who has had anything to do with YASME has been interested in DX—that special activity within the wide scope of amateur radio which consists basically of holding two-way communication with as many different "countries" as possible. At this time, the top DX amateurs of the world have held two-way communication with some 345 different such countries. Some of the areas thus classified as countries consist of remote uninhabited islands and reefs; others are small countries with only one or two radio amateurs. A DX-pedition to such areas is the only way of permitting large numbers of hams to contact them. In addition, the DX-pedition serves the useful purpose of increasing interest and understanding of amateur radio in such remote areas and establishes approved licensing procedures.

From the beginning of ham radio, some radio amateur or group of amateurs have traveled to remote places specifically to set up a radio station so that other hams would have their first contact with that place. Until 1954, however, these trips or "DX-peditions" consisted of hams who made these trips for a weekend or at the most for a fairly limited period of time. The YASME DX-peditions are the first DX-peditions in the world to make such trips on a regular, continuing basis.

In 1954, a young Englishman, Danny Weil, built a small sailing boat in which he hoped to sail around the world. He named his boat "YASME" from a Japanese word meaning good luck. He had no previous sailing experience. He was not a radio amateur. He had only a small boat and a burning desire to conquer the world by sailing around it. After many difficulties, he finally sailed into St. Thomas, Virgin Islands, where he met Dick Spenceley, KV4AA. Dick talked Danny into becoming a ham and suggested to Danny that he go on a world-wide DX-pedition in his small boat and, at each rare spot visited, Danny go ashore and operate his amateur station. This is just what Danny did for the next nine years. All told,

he worked from 27 rare countries. During that period, Danny wrecked YASME I and YASME II and had innumerable exciting experiences—many of which he was lucky to come out of alive.

Danny married in 1960 and after a relatively short period of sailing together, Danny's wife told him that he must choose the DX-pedition or her. Danny chose married life and stopped his travels. Danny wrote a 1,000,000-word book on his many hundreds of thrilling incidents such as the following, written by Danny describing the disaster of YASME II which occurred immediately after he departed from St. Vincent Islands where he had operated around the clock for several days as VP2SW.

"The first grinding crash awoke me instantly. Massive seas broke over the stern, sweeping into the cockpit. For seconds nothing could be seen as the spray blinded me. The grinding and crashing of YASME on solid rock left me under no illusions as to what had happened. Jumping out of the cockpit, I threw the engine astern, opening the throttle wide. A mad rush along the decks to release the sails. As they tumbled onto the deck, I dashed back to the cockpit.

The wind was dead astern, forcing YASME further and further onto the rocks. For seconds she would be afloat; then would come the heartrending crash as the mountainous seas picked her up and crashed her down on the unyielding rocks. How long she would accept this treatment was doubtful. I cast an anxious eye below, but saw no signs of water. Suspecting the worst, I stuck the engine bilge pump on, hoping I wouldn't need it.

The moon, where it had so recently shown peace and magnificence, now showed desolation and horror. Vicious black rocks appeared to surround YASME, as she founght for her life. Dead ahead rose a sheer cliff towering into the sky, acting as sentinel to its myrmidons of small fry. For those brief seconds I thought I had landed into a nightmare.

YASME trembled as the spinning propeller fought with the sea and wind to drag her clear. The interminable crashing and grating as nature strove to destroy her almost drove me insane. All my hopes were tied up in the engine.

Danny Weil operated from G7DW/mm, VP2VB, KZ5WD, FO8AN, VR1B, VK9TW, VR4AA, CR1OAB, YVØAB, VP2KF, VP2AY, VP2MX, VP2KFA, VP2DW, VP2LW, VP2SW, VP2GDW, VP4DW, VP7VB, VP5VB, HKØAA, HC8VB, ZK1BY, ZM6AW, VR2EO, FW8DW.

I kept looking at the rocks alongside. With each rise and fall of the seas, YASME moved an infinitesimal amount astern. Could it be possible she would get off under her own power? My body dripped sweat. I trembled like a leaf as I stood at the wheel leaning astern as though that alone would assist the creaming engine.

The first rock slid out of sight into the seething spray. For those few moments, my hopes rose. She was coming off slowly but surely. Something was amiss. An undercurrent of fear pushed itself up into my feelings of elation. I glanced quickly astern. A mountainous sea was roaring in. Its high breaking crest appeared as jagged white teeth as it swept in to engulf YASME in its maw. Petrified with fear, I gripped the steering wheel, unable to take my eyes from this monster.

Suddenly it struck. YASME rose into the air as though she were a matchbox. As it receded, she came down with her thirty tons dead weight. The wheel jerked itself from my hand. A demoniacal scream came from below as the gear box tore itself apart; then, the engine stopped.

The rudder had been smashed and jammed the propeller. A deathly silence pervaded, broken only by the breaking seas as YASME was swept back onto the rocks. Without power or steerage, she was helpless and I knew her time was limited.

With a superhuman effort, I threw the dinghy over the side. I wanted to get a

rope and anchor out astern to stop her slewing around broadside. As the dinghy struck the water, it was immediately swamped. Attempts to bail it out were futile. Several times I attempted to get into it, but the seas swept it from me. Within a few minutes, it started to fall apart, then it was gone. Only the painter tied to the rail and a small piece of timber hanging from the end proved there was actually a dinghy there at one time. As the oars floated away in the surf, my hopes vanished with them.

I ran below and fired up the rig. I had done my best to save YASME and now it was time to save me. Hanging onto the lurching cabin door, I anxiously awaited the warm-up period . . . . the seconds seemed like hours. It was tuned on 7 MHz and the band was wide open. I snatched up the mike and almost passed out. The entire rig was alive with 110 volts and I was standing in a foot of water. YASME was holed.

I had a choice. Drowning or electrocution. YASME was taking water fast. I stood there fascinated. I could hear many of my friends talking. Any one of them could have organized aid in a few seconds. The transmitter was working and I couldn't even switch it on. What an ironical position to be in!

I hated the thought, but had to accept the fact that YASME was finished. I cursed myself for being all sorts of a fool,

Dick McKercher, WØMLY, operated from WØMLY/TJ8, /TL8, /TN8, /TZ8, /TR8, TY2MY, 5V4MY.

Lloyd Colvin, W6KG, and Iris Colvin, W6DOD, operated from KG6SZ, W6KG/KG6, KC6SZ, KG6SZ/KC6, KX6SZ, VR1Z, GD5ACH/W6KG, GD5ACI/WB6QEP, GC5ACI/WB6QEP, GC5ACH/W6KG, ZB2AX, CT3AU, CT2YA, 6W8CD, 5T5KG, ZD3I, 9L1KG, 5L2KG, TY2KG, 5V1KG, 9G1KG, TU2CA. (photo by EL2NA).

but realized that recriminations wouldn't help. I had to act. I had to do something . . . but what?

I clambered out on deck and watched YASME being forced high onto the rocks. Every crash bit deep into my body like a knife being inserted and twisted. I wanted to scream and pray to God. I wanted to jump overboard and pull her off with my bare hands. To stand there and do nothing drove me frantic and made me feel life just wasn't worth living. I thought of all the work, worry and effort that had made the expedition. All of it wasted through my utter stupidity.

I was ready to give up. It seemed pointless to save even a tube. Without YASME, I was finished, and yet, it seemed so utterly crazy to let all that gear be lost. The old brain box started clicking into high gear, and I thought hard and fast. Moving along the lurching deck to the bow, it appeared I could get ashore with slight difficulty. There were many large rocks partially covered which might be used as stepping stones to the beach. I swung

over the bow, my feet fumbling for a foothold. With the jerking and swaying of the boat, coupled with surging seas, it proved an impossible task. I tried to pull myself up. My body hanging full length was too heavy. My strength was gone. I had little alternative but to drop into the water and hope for the best. It was a rough decision to make but there was no choice. With a prayer on my lips, I let go. I tried to time the drop to coincide with a receding sea, but nature played one of her dirty tricks on me and a double wave came in when it should have been going out and picked me up like a matchstick. For a few seconds, I was completely submerged as I rolled in with the wave. I expected to feel the cruel bite of the rocks any moment and knew my chances were 99 to 1 against survival in that maelstrom of angry water. Strangely enough, I felt nothing. My head broke water and I struck out shoreward, wondering all the time if I was doing the right thing. Guess I was going to have to meet up with those rocks sometime and it may as well be now, as I was pretty weak and couldn't hold out much longer.

Seems we all get that little extra strength in times of need. I found myself a big rock and, swimming to its lea, managed to climb its rough sides with little damage other than minor abrasions. From this vantage point, I was able to make a complete survey. The actual shore was twenty feet from me. Timing my dive right, I did reach the shore O.K. My prayers were surely answered, and I thanked God to be on dry land and safe."

To help obtain funds to get another boat and new radio equipment for Danny after experiences such as just described, a group of influential hams interested in DX founded the YASME FOUNDATION in 1960. This is a nonprofit foundation and qualifies as an organization to which tax-deductable donations may be made.

In 1962 the YASME Foundation also sponsored a highly successful DX-pedition by Dick McKercher, WØMLY, to seven rare countries in Africa.

The YASME DX-peditions so far mentioned were conducted on the basis that amateurs worked were urged to make a small contribution with their QSLs to help defray a portion of the costs. This was, and still is, a highly controversial subject. Some amateurs feel no one in amateur radio should ever send money to help a DX-pedition, while others feel a small donation is more than justified. In any case, the Directors of YASME found that in order to keep DX-peditions such as Danny Weil's going they had to put a lot of their own money into the Foundation. This became a discouraging and expensive procedure and the Directors decided to let the YASME Foundation become dormant unless someone wanted to pay their own way on a DX-pedition and let the YASME Foundation help in other ways than direct financial responsibility.

In 1965, Lloyd Colvin, W6KG, and Iris Colvin, W6DOD, retired from business and went on a sustained DX-pedition under sponsorship of the YASME Foundation. All travel and equipment expenses were paid by Lloyd and Iris, with the YASME Foundation taking care of QSLing and publicity.

During 1965, 1966, and 1967, Lloyd and Iris traveled around the world, primarily by commercial aircraft, and worked from 22 rare countries.

Lloyd and Iris, after some two and one-half years of continuous travel, have decided to stop doing it on a full-time basis. They may, however, make occasional short-period DX-peditions under YASME sponsorship.

During the DX-peditions made by Lloyd and Iris, some donations have been received by the YASME Foundation. About half of the money so received has been used on QSLing expenses. The balance is held by the YASME Foundation which wishes to announce to the radio amateurs of the world that their donations will be spent for equipment in accordance with the following resolution passed by the Board of Directors of YASME:

"IT IS RESOLVED that the Treasurer be authorized to purchase radio equipment from cash on hand and that said equipment will be loaned to amateurs approved by the Foundation who are going on DX-peditions, and who agree that the confirmation cards, or QSLs issued for contacts with said DX-peditions will give printed acknowledgment to YASME FOUNDATION for supplying the equipment used, and further providing that said amateurs using said equipment will first sign a written agreement to return

said equipment immediately upon completion of the DX-pedition in good condition, reasonable wear and tear excepted."

Anyone desiring to use such equipment for a DX-pedition, under the sponsorship of the YASME Foundation, is invited to write to the Foundation.

This article would not be complete without paying tribute to the Directors of the YASME Foundation, most of whom have been associated with it since the early DX-peditions made by Danny Weil, and all of whom have devoted much time, energy and money to further DX. The present Directors are Danny Weil (now a U.S. citizen, living in Texas); Bob Vallio, W6RGG (QSL manager and the hardest working man in the organization); Tom Taermina, WA5LES (publicity director and Editor of the West Gulf DX Bulletin); Ed Peck, W6LDD; Charles Biddle, W6GN; Golden Fuller, W8EWS; Hal Sears, K5JLQ; Jack Drudge-Coates, G2DC; and Dick Spenceley, KV4AA.

SAMS Books

People working in the electronics field appreciate its very great complexity, and usually spend some time learning more about the fundamentals and the technology. And the field is changing all the time, so that what is basic one year may be outdated the next.

Good study material is always valuable and may serve as a very useful advancement tool, also. Here is an example. Sams has just published a four volume set of books on transistor fundamentals. Their set covers the whole range from basic ideas (which should be reviewed, and not too rarely), through special circuits.

The four books are titled *Basic Semiconductors and Circuit Principles, Basic Transistor Circuits, Electronic Equipment Circuits,* and finally *Digital and Special Circuits.* This arrangement is something like a large novel in four volumes, in which you must start at the beginning to understand what it's all about.

Look for these and other SAMS books in your local amateur radio or other electronics oriented store. Or you can get them direct from SAMS at $4.50 each or $15.95 for the set.

The LC Power Reducer

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Reducing the power output of a transmitter or exciter while still having it work into the same load conditions as under full power output is usually accomplished by means of relatively expensive resistor T networks. This article presents a simple LC network which will much more economically accomplish the same purpose. Its operation has been proved by extensive usage in the broadcast field for high-power transmitters.

There are many reasons why one may wish to reduce the power output of a transmitter or exciter: for test purposes, to provide the proper drive level for high-power linears, to reduce QRM by using only the power required for a QSO, etc. The circuit described in this article affords a simple method to provide almost any desired degree of power reduction on any single amateur band. Perhaps the most outstanding feature of the circuit is that it uses only one resistor—a 50 ohm unit (for 50 ohm coaxial lines) which may, in fact, be the regular station dummy load. Therefore, no special high-wattage, non-inductive resistors of odd values are necessary as with conventional resistor-network power reducers. Not only are such resistors generally expensive and difficult to find, but they allow only one fixed value of power reduction. Certainly, they represent a very expensive item when a power reducer is desired only for occasional test purposes.

The circuit described in this article is certainly not new and no claims are made in that direction. Broadcasters will recognize the circuit as one which has frequently been used to reduce the output of high-power broadcast transmitters. It has not, however, received any usage by radio amateurs, probably because it was developed before the advent of high-gain, high-power linears required many amateurs to reduce the output and load conditions of the final stage as though the exciter were operating at full power output.

Basic Circuit

Fig. 1 shows the basic circuit of the power reducer. The two reactances form a power divider and the ratio of their values determines how much of the input power flows into the dummy load and how much power flows into the output load. When the dummy load and the output load are both 50 ohms, the input impedance will remain a constant 50 ohms regardless of which power reduction ratio the reactive elements are set up to accomplish. If the circuit is redrawn, as in **Fig. 2**, its operation may be clearer. At any particular frequency, the circuit is that of a simple voltage divider network. Note that since both the dummy load and actual load resistances are equal, they can actually be interchanged. This feature will be found of value, as explained later, when reactance values which are also physically possible must be determined.

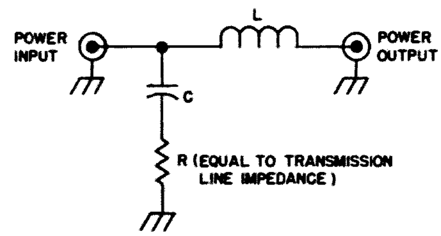

Fig. 1 Basic circuit of the LC power reducer.

Circuit Value Calculation

The value of the dummy load resistor is simply equal to the value of the transmission line impedance being used, usually 50 or 70 ohms. The power rating of the resistor is simply determined by the power reduction the whole circuit is desgined to achieve. If the output of a 500 watt transmitter is desired to be reduced to 50 watts, for example, the dummy load resistor must, naturally, handle the surplus 450 watts.

The value of the reactive elements is determined from the following formulae (substitute 70 for the 50 values shown if a 70 ohm coaxial system is used instead of a 50 ohm system).

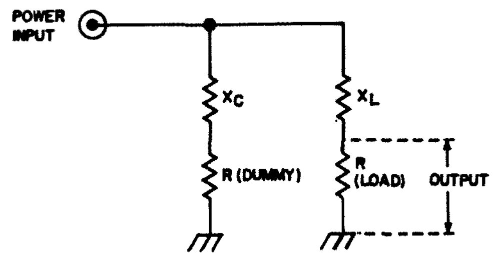

Fig. 2 The equivalent of Fig. 1 at any particular frequency is a simple divider network. Both resistances are the same value.

X (in series with dummy load)

$$= \frac{50}{\sqrt{\frac{P_{IN}}{P_{OUT}}}} \text{ ohms}$$

X (in series with output load)

$$= \sqrt{\frac{P_{IN}}{P_{OUT}}} \text{ x } 50 \text{ ohms}$$

Note that no signs are shown for the reactive values. The only criteria is that they be of opposite values but which one is capacitive and which is inductive is not theoretically important. An example should make this point clear.

Suppose it is desired to reduce the output of a transmitter from 500 to 50 watts, operating at 4 MHz and using 50 ohm transmission line. Then,

$$\text{X (dummy)} = \frac{50}{\sqrt{\frac{500}{50}}} = 15 \text{ ohms}$$

$$\text{X (output)} = \sqrt{\frac{500}{50}} \text{ x } 50 = 165 \text{ ohms}$$

If it is desired to use a capacitive reactance in the dummy load leg, one looks up from a handbook graph the value of capacitance producing 15 ohms at 4 MHz (or calculated from the formula ($\text{pF} = \frac{1590 \text{ x } 10^8}{\text{f(Mc) X}}$) which is 3,000 pF. The output leg must then contain an inductive reactance of 165 ohms at 4 MHz which is 5.4 μH.

$$\text{L}\mu\text{H} = \frac{159000\text{X}}{\text{f(MHz)}}).$$

If one were to reverse the reactances, their values have to be determined again (the actual capacitor and inductor cannot be simply exchanged). An inductor in the dummy load leg would have 15 ohms reactance and a value of 0.6 μH. The capacitor in the output leg would have 165 ohms reactance and a value of 250 pF. The two circuits which result from these calculations and which perform exactly the same degree of power reduction are shown in **Fig. 3.**

If the reader wants to check the calculation of the reactive values, another example would be the reduction of the power output of a 100 watt transmitter to 10 watts at 30 MHz. If a capacitor is used in the dummy load leg and an inductor in the output leg, the circuit values are 360 pF and 0.9 μH. If an inductor is used in the dummy load leg and a capacitor in the output leg, the values are .08 μH and 30 pF.

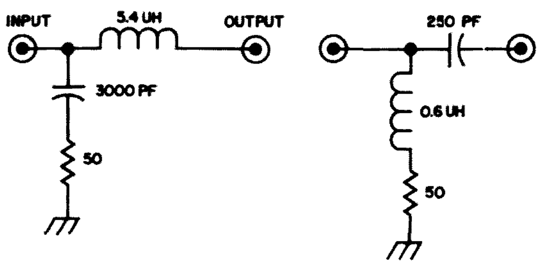

Fig. 3 Both circuits shown achieve a 10 to 1 power reduction ratio at 4 MHz. The method of determining the inductor and capacitor values is explained in the text.

Construction

Before a unit is constructed the reactive values necessary for both circuit options should be calculated in order to check which option fits parts on hand or is easier or cheaper to construct. For instance, if using new parts, the circuit of **Fig. 3(B)** would certainly be less expensive than that of **Fig. 3(A).** In the 30 MHz example given, the circuit option which produced an 0.9μH inductor would certainly be less critical to construct than that producing an 0.08 μH inductor.

No special construction methods are necessary and the components can be enclosed in a standard minibox. If the inductor is in the output leg, its wire size need only be appropriate for the amount of current produced by the output power in a 50 ohm line and results in a relatively inexpensive

inductor if a large amount of input power is being reduced to a low value. The capacitor should be a mica transmitting type and its minimum voltage rating can be determined by finding the current flowing because of the power dissipated in the leg in which it is used and then simply determining I^2Xc. Normally, the voltage rating will be quite low for even high powers but the current (rf) rating of the capacitor should also be checked with the manufacturer's rating.

Summary

The LC power reducer can be built and used in a number of versatile ways. Since it uses a standard dummy load resistor, it can be built as part of a dummy load. A tapped coil and variable or switched capacitor can be used if multi-band operation is desired. Or a variety of power reduction levels for one band, while maintaining constant transmitter loading, can be achieved using a variable inductor and capacitor. To achieve the same flexibility with purely resistor networks would require a very elaborate and expensive collection of switches and resistors indeed. . . . W2EEY

Amphenol's Color Commander Generator

Service oriented amateurs will be interested in Amphenol's new color bar generator. Priced at $139.50, it generates a set of nine assorted patterns for adjustment of centering, convergence, and other service controls of any color TV set.

Patterns consist of a single vertical or a single horizontal crossbar or the two combined; a single center-screen dot, three color bars, several horizontal and vertical patterns, and square or dot patterns for dynamic proportioning and convergence adjustments.

The Amphenol Color Commander contains an internal rf generator whose output is applied to the receiver's antenna terminals. Color sync and other circuits may be checked because the Color Commander uses a crystal oscillator with unijunction transistor countdown circuits for accuracy and stability. Operates from batteries or from an ac supply in the battery compartment.

For additional information on their Model 860 Color Commander, contact Amphenol Distributor Division, the Bunker-Ramo Corporation, 2875 South 25th Ave., Broadview, Ill. 60153.

Why Ham RTTY

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The symbol "F-1" on authorized emission charts in FCC regulations may not mean much to some amateurs. To others it is an open door to an entirely different concept of communications. It signifies a technology which is challenging enough for the most learned engineer, yet basically simple enough for the greenest neophyte. This symbol "F-1", along with the symbols "A-1" and "A-2" authorizes amateur radio-teletype (commonly called RTTY) on all bands except 160 meters.

The word "Teletype" is actually the trademark of the leading manufacturer of teleprinter machines, the Teletype Corp. Over the years "teletype" has come to be a term used synonymously with "teleprinter" which is the actual descriptive name of the machine.

"Why Ham RTTY?", you ask, when we have CW, AM and SSB available to communicate with other amateurs in most countries throughout the world. The answer is simple. Amateur radio, by international agreement is designed as a service dedicated to furthering communications technology all over the world. It is a means of bringing together people from all walks of life, all races, creeds and religions who share a common interest, i.e. to communicate ideas and thoughts to each other. Amateur radio is also dedicated to furthering technical knowledge of many different means of communication by encouraging experimenting in these areas. This is commonly called "advancing the 'State of the Art'".

Amateur radio is made up of thousands of hardy individuals who are looking for a challenge or project just a little bit more difficult than the one they have just been involved in. These are your "experimenters" and "builders". These people, although not forsaking the old tried and proven ideas and modes of communication, are interested in new and different means of communicating. It is these people who look to the different areas of amateur activity such as Amateur Television. Facsimile, Slow Scan TV, FM, narrow band FM and Amateur RTTY for their enjoyment.

For many years, commercial telephone and telegraph companies have used teletype to transmit and receive printed messages from point to point in the U.S. and other countries. Teletype is a means of transmitting signals through wires from one teletype machine to another by the switching on and off of a dc voltage in a code pattern which the machine understands and converts to mechanical motion causing a type character to strike a sheet of paper thereby printing the message in directly readable form.

Amateur radio operators saw the opportunity to utilize another communication media when these machines came into use. The first problem they had to overcome was how to get the pulsing code signals from one machine to another. After trying various methods which worked crudely and only at times, these pioneers developed the process now called "Frequency Shift Keying" (FSK) or F-1 as termed by the FCC.

The FSK transmitting process is basically this: The transmitter is on the air and transmitting steadily at a given frequency called the "mark" frequency. When the desired character key on the teletype keyboard is depressed, a motor driven mechanism produces a switching off and on, in a code group assigned to the desired character, of a dc voltage. This voltage then activates an electronic unit which either directly or indirectly causes a reaction in the transmitter's frequency generating section which shifts the transmitted frequency very slightly for a period of about 22 milliseconds. It is this short period of frequency shift, when transmitted in code groups of the proper pattern, carries the teletype signal over the air. The frequency shift may be any value up to 900 Hz as allowed by FCC regulations. The most commonly used shift is 850 Hz although shifts as low as 170 Hz and 160 Hz are being used occasionally. This shifted frequency (generating the mark frequency minus 850 Hz) is called the "space" frequency.

A variation of the FSK which is authorized on high bands only (6 meters & up) is AFSK which means Audio Frequency Shift Keying. This method utilizes the constant carrier on action of either AM or FM but instead of a voice signal being transmitted, an audio tone of 2125 Hz is generated in an audio signal generator and shifted by the teletype machine 850 Hz to a tone of 2975 Hz. This audio signal is impressed upon the carrier frequency in the same manner that a normal voice signal would be transmitted. This system does not involve changing of the basic transmitting frequency as does the FSK system.

The receiving of RTTY signals requires receiving equipment of reasonable stability and selectivity. The incoming FSK signal is treated the same as a CW signal in that it is detected and changed to an audio signal by the BFO control on the receiver. The audio output to the speaker is tapped and some of this signal is fed to the RTTY converter. The converter amplifies these signals slightly and feeds the complete audio signal through two audio filters which only allow audio tones of a certain frequency to pass through them. These filters do not allow any other audio frequency to pass except the frequencies the filters are designed for. Usually these two audio frequencies are 2125 Hz and 2975 Hz. The BFO on the receiver is tuned until the steady audio tone coming from the receiver is 2975 Hz (mark freq.). This audio tone will pass through the "mark" filter. The frequency shift of 850 Hz will change the audio tone to 2125 Hz (the "space" freq.). This tone will pass through the "space" filter on the converter. These two audio tones are then amplified further and one or the other becomes the triggering pulse for an electronic switch which switches off and on the dc voltage in the proper sequence necessary to operate the teletype printing mechanism. The proper combination of off-on pulses of the dc voltage being fed to the printing unit then sets up the mechanical reaction necessary to print the proper character on the paper.

The equipment involved need not be expensive. In fact, by using an existing AM/CW transmitter (either crystal or VFO controlled) and the station receiver you already have, you can be on the air on RTTY for less than the cost of most SSB transmitters on the market today. The teletype machine itself will probably be the most expensive investment, costing anywhere from $20.00 and up, depending upon your source of supply. The RTTY converter can be either purchased commercially or home brewed from your junk box (or your buddy's) according to many schematics available today. The cost of this unit could run anywhere from $15.00 and up for a home brewed unit, to nearly $200.00 for an exotic commercially built version. The FSK unit generally must be designed and built to match whatever transmitter you are planning on using.

There are several good publications available today which carry schematics and construction details of converters, FSK units and other handy RTTY gear. These can be found listed in catalogs published by most electronic suppliers.

Ham RTTY is a service of high value in message handling and net activities. It is also a tremendously fascinating field which, as I stated before, can be challenging enough for the most experienced engineer yet basically simple enough that the newest ham can understand it.

This article was written, not to make RTTY experts of any of its readers, but, mainly to whet the readers' appetite to want to learn more about this fascinating phase of amateur radio. Amateur RTTY has its problems and frustrations just like the other modes but that is the real test of an amateur's dedication and zeal towards the goal he pursues; which is to advance the 'State of the Art'.

. . . WA8DCE

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Panadaptor or Spectrum Analyzer

Definition

A panadaptor, or radio-frequency spectrum analyzer, is a device which provides a panoramic display of the signal distribution in a selected portion of the radio-frequency band. The display takes the form of a plot of amplitude versus frequency, usually on the screen of a cathode ray oscilloscope.

History

Little work was done in the field of panoramic presentation of radio frequency spectra during the years preceeding World War II. However, the huge amount of organized research and development work in the field of microwave radar performed as part of the war effort caused a tremendous expansion in radio measurement techniques and measuring apparatus. At the Massachusetts Institution of Technology Radiation Laboratory, spectrum analyzers of various types were developed for use as test equipment in the design of pulsed oscillators for radar transmitters.

Although this first use of the spectrum analyzer was quite far removed from ham radio, it was not long before a ham decided this would be an extraordinary way of monitoring an entire ham band at a glance. Exactly when the first spectrum analyzer was used on the ham bands is not known to the author. The Hallicrafters Company, however, produced a commercial unit shortly after the war in early 1946. This was known as their model SP-44 Skyraider Panoramic. The unit was not widely accepted and was generally termed a worthless device and soon almost forgotten. The panadaptor did not become widely known again until 1965 when Heathkit introduced their Ham-scan Model HO-13. Today the basic operation is known to most all hams and some have learned to

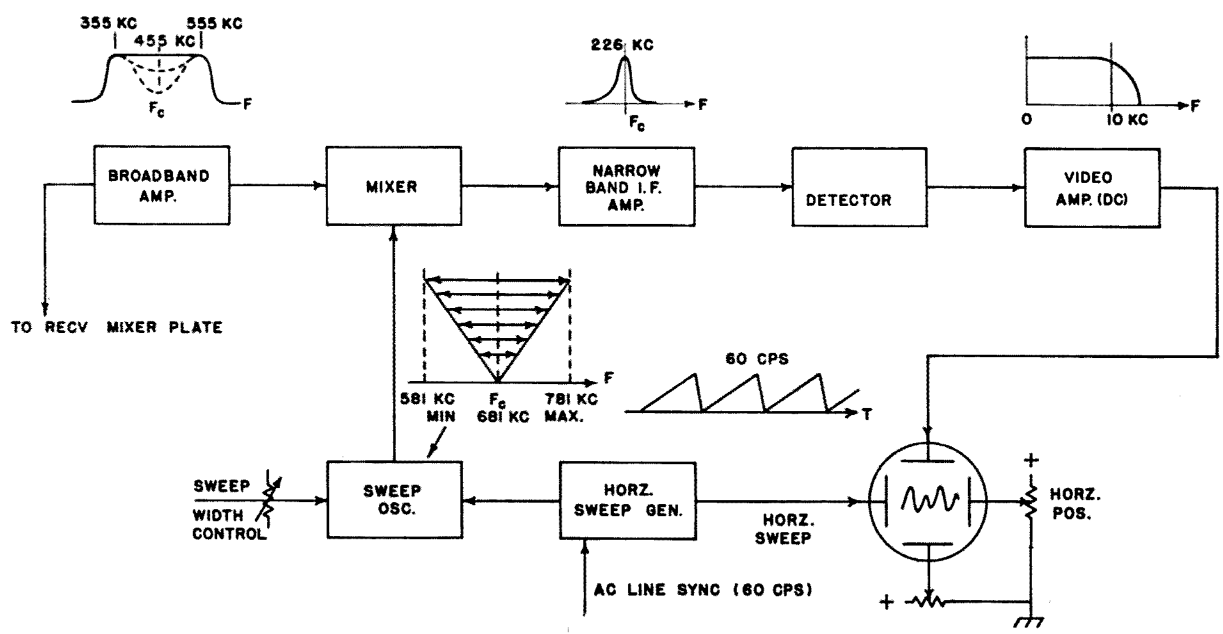

Fig. 1. Block Diagram of panadaptor spectrumanalyzer.

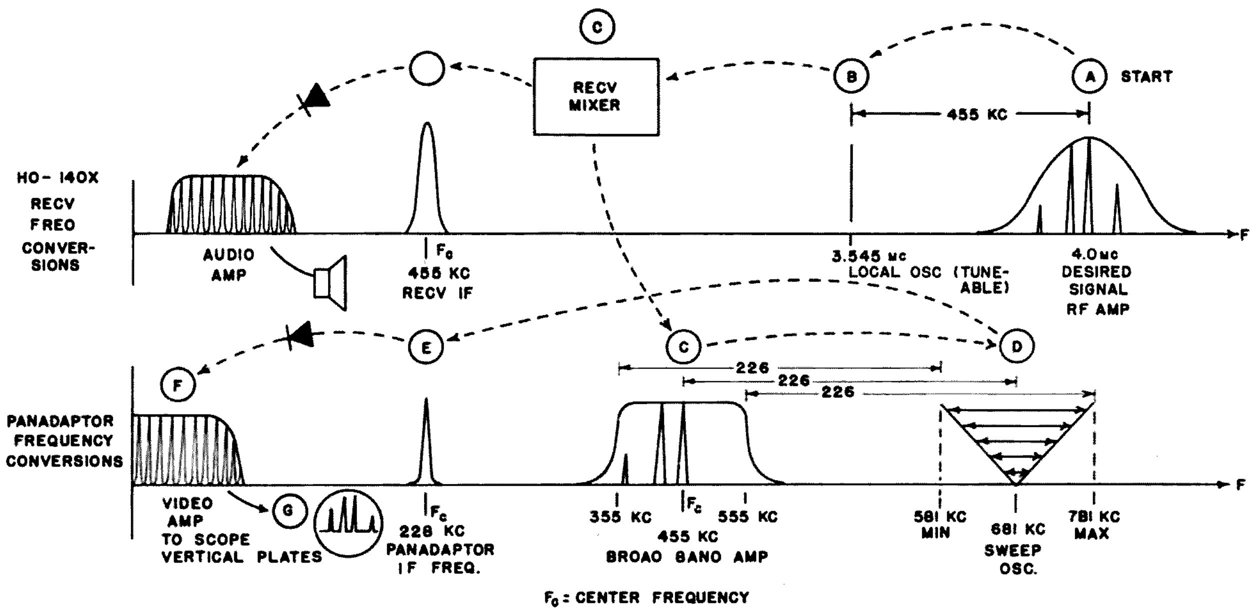

Fig. 2. Frequency conversions in a Panadaptor system.

A. Receiver rf amplifier showing broad band pass and four stations.

B. Receiver local oscillator displaced 455 kHz from desired station.

C. Here signal splits between receiver if and to panadaptor broadband input amplifier.

D. Variable sweep width FM oscillator mix with signals from broadband amplifier. Those with 226 kHz frequency difference pass on into panadaptor if amplifier.

E. Panadaptor if amplifier band with sets resolution of system.

F. if signal rectified and audio components send to scope plates.

G. Scope presentation shows stations as in A.

use it to great advantage in every day spectrum and signal analysis.

Operation

A spectrum analyzer is essentially a narrow-band superheterodyne receiver which is repeatedly swept in frequency over a selected portion of the radio-frequency band. At the same time, the horizontal deflection of the spot on a cathode ray tube moves in synchronism with the rf sweep. The vertical deflection of the spot is proportional to the output voltage of the receiver. The resultant display is a plot of amplitude versus frequency over the radio-frequency band of interest.

Fig. 1 illustrates a block diagram of a simple spectrum analyzer such as the Hallicrafters SP-44 and the Heathkit HO-13. This block diagram, of course, shows only the basic elements that are necessary to explain the operation of the analyzer. It can be seen from the block diagram, the primary deviation from a standard superheterodyne receiver is the horizontal sweep oscillator and a cathode-ray tube readout in place of the speaker. A careful study of this diagram and of the Frequency Conversions diagram (See **Fig. 2**) should illustrate basically how the panadaptor works. **Fig. 3** shows some typical wave forms which can be expected.

Uses

The panadaptor is best known for its abilities as described above, to provide a panoramic display of radio signals in a selected portion of the radio frequency spectrums. This first use is probably what caused a loss of interest in the device as one soon tires of only eavesdropping on the amateur bands. Only when you delve into the theory of the device, understand, and try to find new uses does it become useful. The following ideas are a few to which I have put mine to use:

1. Watch the stealthy spectrum pirate. He is the one who slyly tunes up on another frequency and then slides down 10 KHz to the frequency his buddies are on. You may also watch the band swoosher go by and track him to a frequency where he may finally identify himself.

2. Watch for band openings on the higher bands. With the receiver set in the

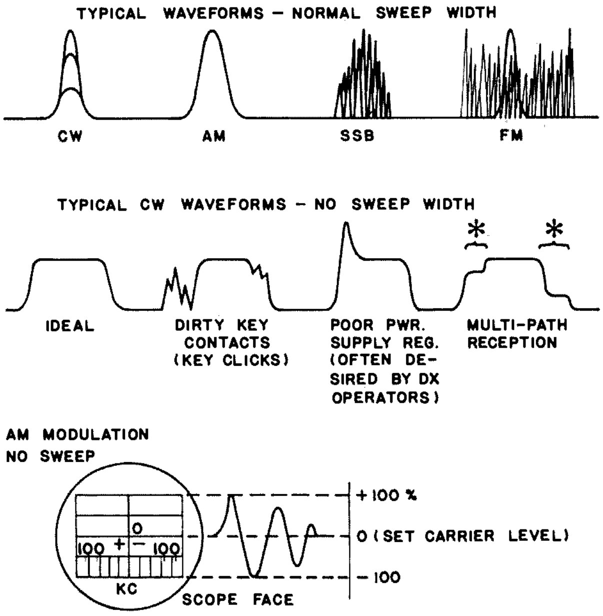

Fig. 3. Typical panadaptor wave forms.

middle of the 15, 10, or 6 meter band, watch for the signals to pop up.

3. Analyze modulation of other stations. Decrease the sweep-width to zero and you have a modulation analyzing oscilloscope. This will detect modulation percentage of AM and flat-topping of SSB.
4. Examine any mode signal (AM, CW, SSB) for spurious radiations—Splatter or parasitics have been quickly traced to the originating station with this device. (Take notice 00s.)
5. Examine keying characteristics of CW stations—Drop the sweep-width to zero and watch. (See **Fig. 3**) You must be careful on distant stations on the lower band as they are very susceptible to multipath propagation and distortion of the waveform.
6. Examine characteristics of multipath reception and radio propagation in general by using the time domain reflectometry technique. In time domain reflectometry, a sharp front long period signal is sent out and the measurements are made by the effects of the reflected signal on the amplitude of the original signal. An example is shown in **Fig. 3** of the CW multi-path reception. This technique is opposed to the pulse-echo method used in radar where a sharp pulse is transmitted and the echo is awaited. Time domain reflectometry is practical in ham radio as the pulse may easily be generated by a "bug" or "automatic keyer" and does not take up valuable radio-spectrum. I have measured the virtual height of the "E" layer by this technique.
7. Find open spots in the bands for transmitting.
8. Monitor own transmitted signal through receiver—Check for modulation and spurious radiations.
9. Zero beat WWV with the 100 KHz calibrator.— By watching the "pulsations" of the waveform on the scope, it

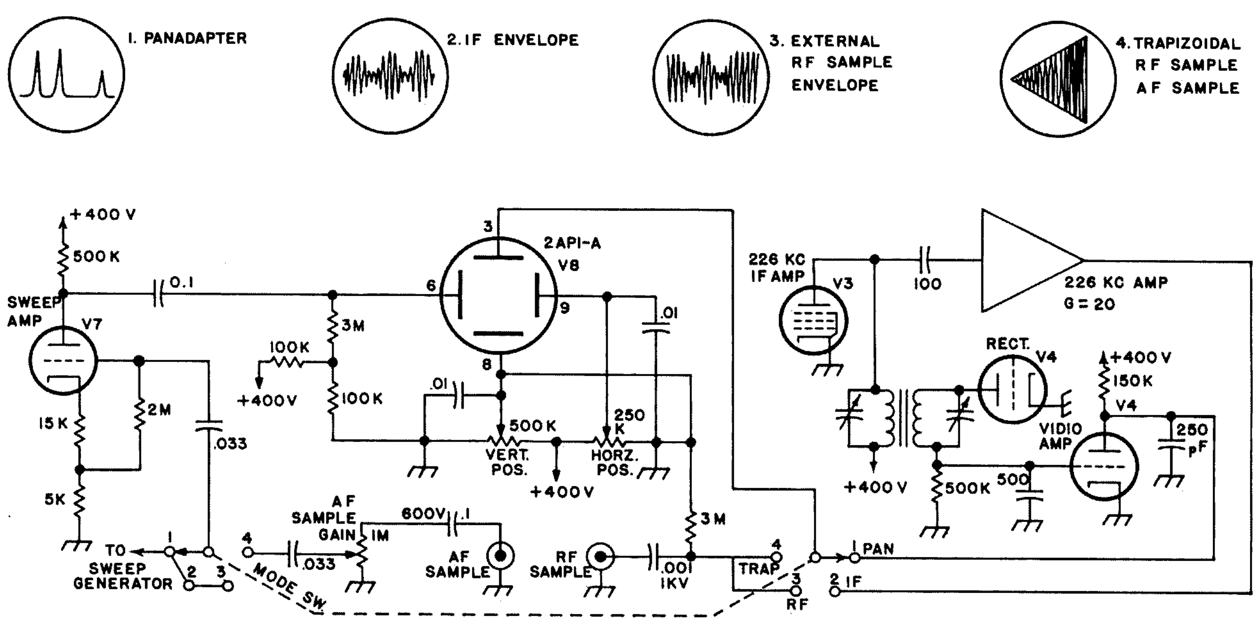

Fig. 4. C.R.T. Plate deflection circuits. Modified SP-44.

is possible to zero beat well below the audible beat. You may also check your own line frequency by watching the 600 Hz note on WWV. You'd be surprised how poor our 60 Hz line frequency is.

In addition to the nine described above, a modification to the panadaptor will add to the uses to which it may be put.

Modifications

On my Hallicrafters SP-44, I have made modifications to the circuits so the cathode-ray tube may be used for multi-purposes. A four position switch was added and the following uses were added to the panadaptor:

1. Normal panadaptor - standard uses as noted above.
2. *rf* Envelope presentation of panadaptor *if*.
3. *rf* Envelope presentation of external transmitter - A jack was added on rear apron for *rf* sample.
4. Trapezoidal pattern of external AM transmitter. A jack was added on rear apron for *af* sample. This switch position combines *rf* and *af* samples to give trapezoid pattern.

See **Fig. 4** for modifications to SP-44. These modifications were made only to the horizontal and vertical deflection plate circuits. Therefore, the modifications shown in **Fig. 4** only show those circuits driving the deflection plates. Any good handbook on ham radio and modulation techniques will describe what they can do for you.

Summary

I have found that the panadaptor is one of the most useful instruments that I have in my shack. In ham radio you normally use only one of your body senses in making contacts and that is the sound that impinges upon your ear. The panadaptor adds a second and that is sight. The ability to *see* as well as *hear* what is going on in a band adds a third dimension to amateur radio.

. . . W6DTR

Please Use Your Zip Code When Writing 73

The "Six Net"

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Did you ever build a receiver that has sensitivity, selectivity and stability? In most cases one may have to be sacrificed for another. Here is a receiver that has all these features. The complete receiver is constructed on a 4 x 6 x 2 inch chassis and a 4¼ x 6 x ⅛ inch panel, including the ac power supply.

The receiver is a 10 transistor superhet which includes the 2 transistors in the Miller *if* strip. The *rf* section is a common base amplifier followed by a common emitter mixer. A special variable crystal oscillator and multiplier injects a signal 455 kHz above the incoming frequency. The oscillator is an untuned common emitter crystal controlled oscillator. The capacitor in series with the crystal varies the frequency 2 to 10 kHz being multiplied depending on the type of crystal used, and its activity. An amplifier multiplier section follows the oscillator. The multiplied frequency is injected in the emitter of the mixer. The difference is amplified and detected and then is amplified by the audio amplifier.

The power supply is a voltage doubler, which is regulated by 2 2N706's (cheap kind) as reference voltage and a 2N1038 transistor. This makes a fine regulated power supply.

The majority of the parts may be purchased through your Allied Radio parts catalog except for the coil forms, which were purchased from Newark Radio. The coil forms are Camboin SPC-1 2170-3-3.

I started with the circuit boards. Use the patterns in this article, they are full scale, or try your own design. I used one side foil boards, they are cheap and less complicated in laying out circuits. Your local drug supply should have Ferric Chloride on hand in the solid form or he can get some from his supplier. Dissolve it in hot water and make it strong. I keep dissolving until the solution is almost saturated. Be careful not to spill any; it sure makes a mess. Use only plastic or glass trays for etching. I watched aluminum disappear before my eyes. I used a commercial resistant, but if not available, finger nail polish or model

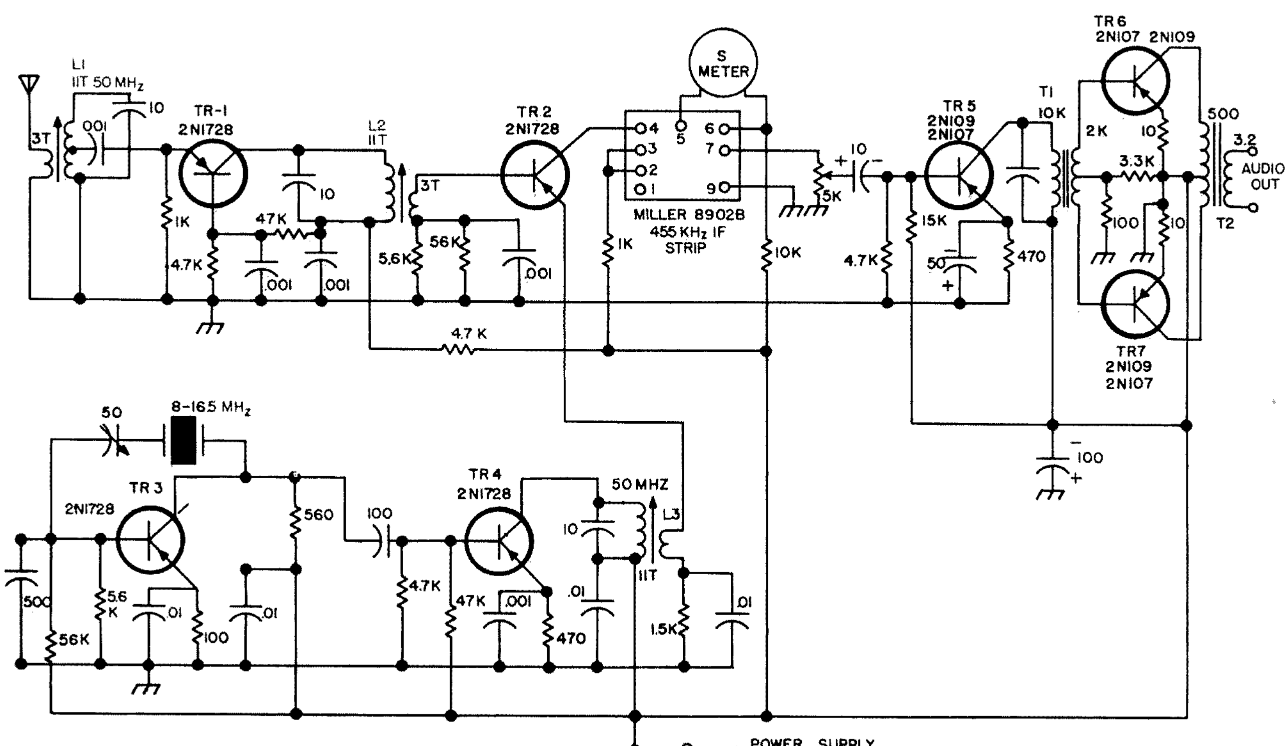

Fig. 1. Schematic for the "Six Net" receiver.

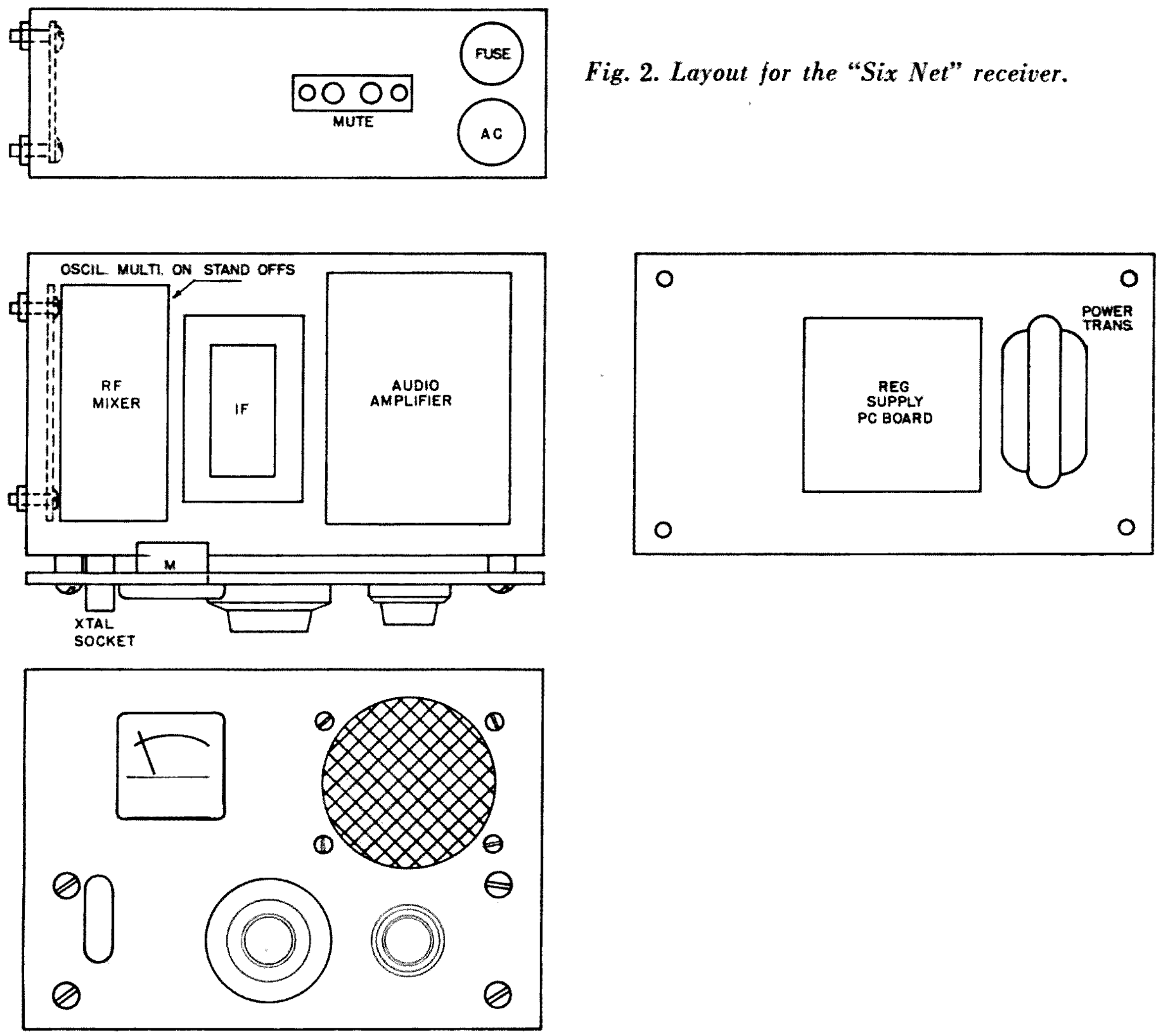

Fig. 2. Layout for the "Six Net" receiver.

airplane dope will do. It takes approximately 25 to 30 minutes to etch, depending on the strength and temperature of the solution. After the PC boards are completed, drill all holes to take the components and solder them in place. The Miller *if* strip sells for less than $6.00 from Allied Radio. The Miller part number is 8902-B. The transistor driver and output transformer are the standard run-of-the-mill transformers. Almost any of the electronic supply houses have them. The power transformer is an Allied 6.3 @ 0.6A number 54-1416. If anything larger is used it may not fit inside the chassis.

I used a Bud 4 x 6 x 2 inch chassis. The chassis was cut out to take the PC boards as illustrated, except for the oscillator and the regulated power supply. These were mounted on stand offs. The oscillator multiplier is mounted on ½ inch stand offs on the left inside of the chassis below the rf mixer and at right angle to it. The power supply board is mounted on ⅜ inch standoffs on a 4 x 6 x ⅛ inch sheet aluminum which is used for the bottom cover plate. Make cut outs for the meter, speaker, crystal socket, variable frequency control, and the volume control, as illustrated. I used ¼ inch standoffs between the panel and chassis for easier assembly. Cut out the holes on the front and rear of the chassis for the controls on the front, and the ac line, fuse holder, antenna connection and muting terminals on the rear. Assemble the receiver as indicated on the schematic and illustrations.

After the wiring has been completed, check it very carefully, making sure no mistakes were made. Dip the rf and mixer coils to approximately 50.4 Plug in an 8325 Hz crystal and turn on the receiver. Ad-

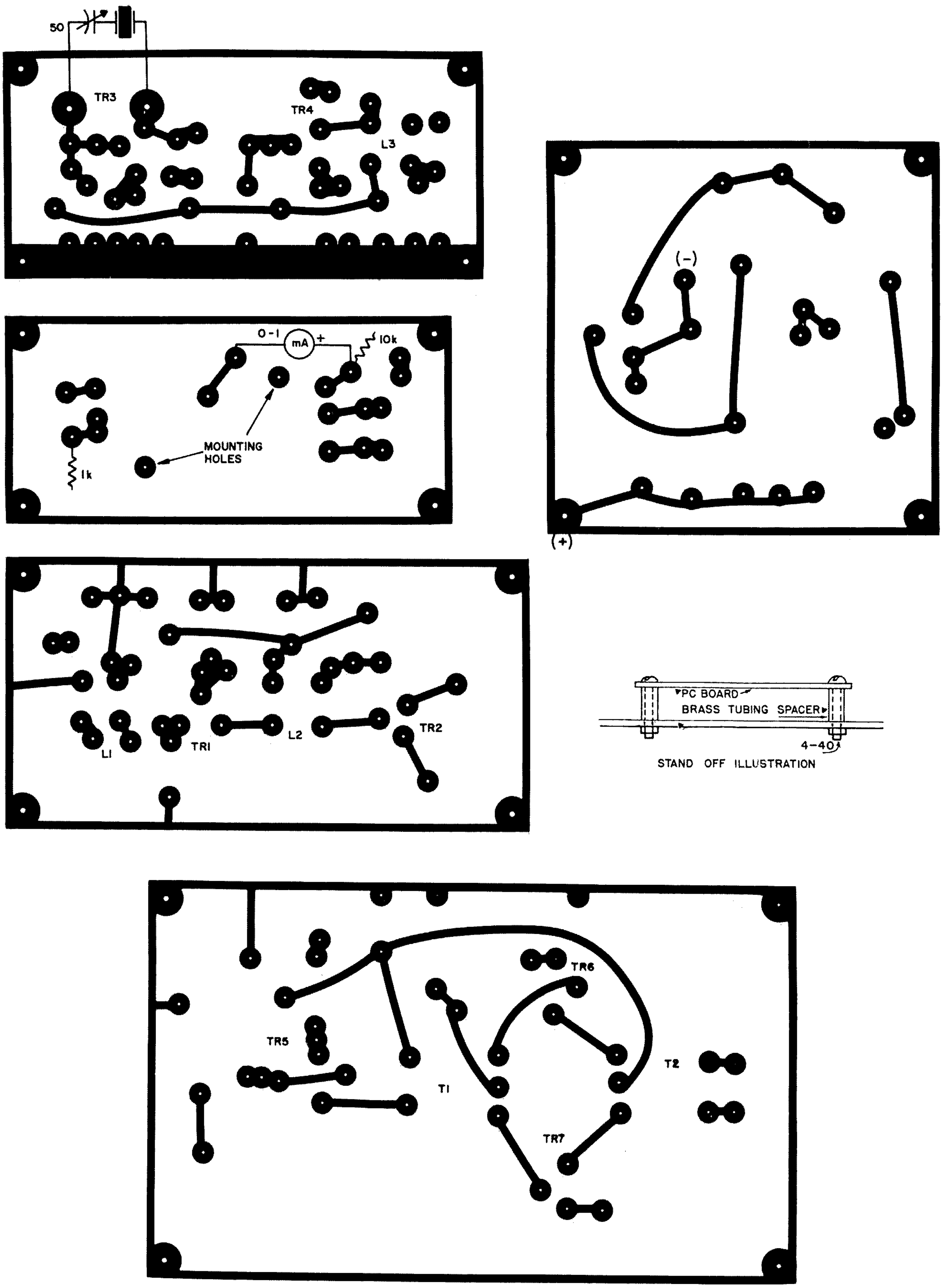

Fig. 3. Printed circuit patterns.

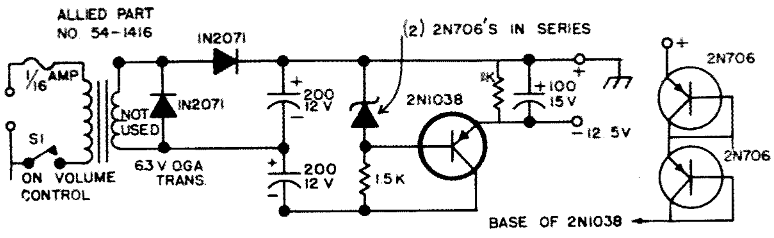

Fig. 4. Diagram for the power supply for the "Six Net" receiver.

just L3 for maximum output with a VTVM. By doing this the receiver will cover frequencies between 49.98 and 50.8 MHz without readjusting L3. Peak L1, L2 and the Miller *if* strip using a signal generator or on the air signal. Here I used the S meter to peak the receiver. The meter will dip, not increase with increase of signal.

The oscillator was checked for stability with a Hewlett Packard counter. The results were no more than plus or minus 20 Hz for any one hour period. I watched the counter for a 15 minute period and observed only 5 Hz change. The tests were made with an 8 MHz xtal.

I have been using the receiver on MARS nets for the past 3 months with excellent results. Here is one receiver which does not require readjusting unless the other stations are off frequency. This will not do for a knob twister.

. . . W5JSN

Pill Box Makes Module

The cylindrical pill box used by most druggists can be made into a module for small electronic circuits. Just take the top off the box and attach an octal plug to the top. The exact method of doing this will depend on whether you use a commercial plug or a salvaged tube base. Now build your circuit so that it fits in the pill box and solder all the power, signal and ground leads to the octal plug with all connections corresponding to the mating socket. For permanence, a bit of epoxy glue will keep the top of the box and the box proper together. A natural use for this type of module is a solid state rectifier replacement for tube rigs.

Pill boxes can also be used to cover relays and keep dust from causing erratic operation.

If you are luckier than most people and don't take pills, you can buy these pill boxes from a druggist for about a nickel apiece.

D. E. Hausman VE3BUE

An Operating Console

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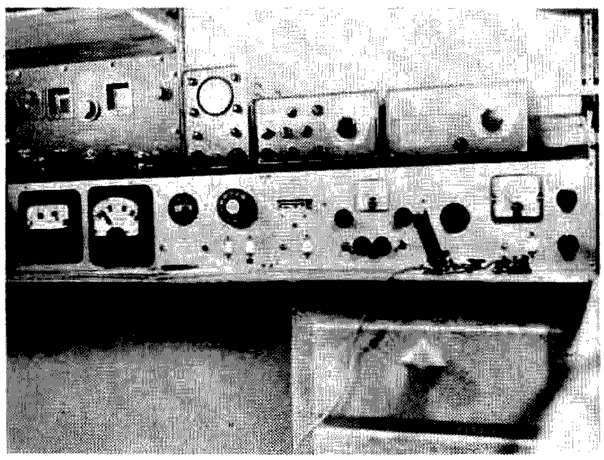
San Francisco, Calif.

Suggestions for Dressing up the Station and Improving Operating Convenience



Most of us started in amateur radio with rather simple equipment in the shack, i.e., transmitter, receiver, mike and key. We all have a tendency to improve and upgrade the station by adding outboard accessories. If you are a typical amateur, the chances are that, after a short time, your operating position will begin to resemble a storage area for black boxes, meters, dials and wires. These outboard accessories usually include: clock, SWR bridge, voltmeter, phone patch, field strength meter, antenna switch, telephone, ten minute timer, etc., et al.

As a first step in improving the appearance of the station, as well as operating convenience, the author decided to mount all the outboard equipment at his station in one console. The photo shows this console which includes all of the above mentioned accessories with room left for future expansion.

The console front was made from ⅛" aluminum panel and the case from ⅜" plywood on a 1" frame, well reinforced. The accessories, which were already mounted in boxes or cabinets, such as the SWR bridge, were installed in the panel after first making a cardboard template of the parts which would project through the panel, to aid in their cutout; then the boxes were mounted against the panel by metal straps.

All panel cutouts were made with ¼" electric drill and sabre saw using a metal cutting blade. A valuable aid in working wih aluminum, using electric hand tools, is an SCR speed reducer to limit the speed to fit the condition; several such kits are on the market.

The console overall dimensions should be adequate to house the equipment to be installed and should be sufficiently sturdy to support the transmitter, receiver or other equipment which may set on top. It can easily be built into a desk at an angle if a sloping face panel is desired. The overall dimensions of the author's are 51" long, 8" high and 15" deep.

It was decided to monitor both ac voltage and current using switchboard type meters which are usually available surplus at very reasonable cost. The ammeter reads direct from 0 to 5 amps. An additional scale from 0 to 25 amps (to be used when a linear is in operation) was incorporated by switching in a surplus 200 to 5 amps ratio current transformer in the primary. Eight turns of the primary 120 volt wire through the transformer window will produce 5 amps in the transformer secondary with 25 amps flowing in the primary. Other ratios are usually obtained by varying the number of turns. **Fig. 1** shows the complete 120 volt ac power wiring which should be at least #10 in size but in no case smaller than that required to carry the current and meet

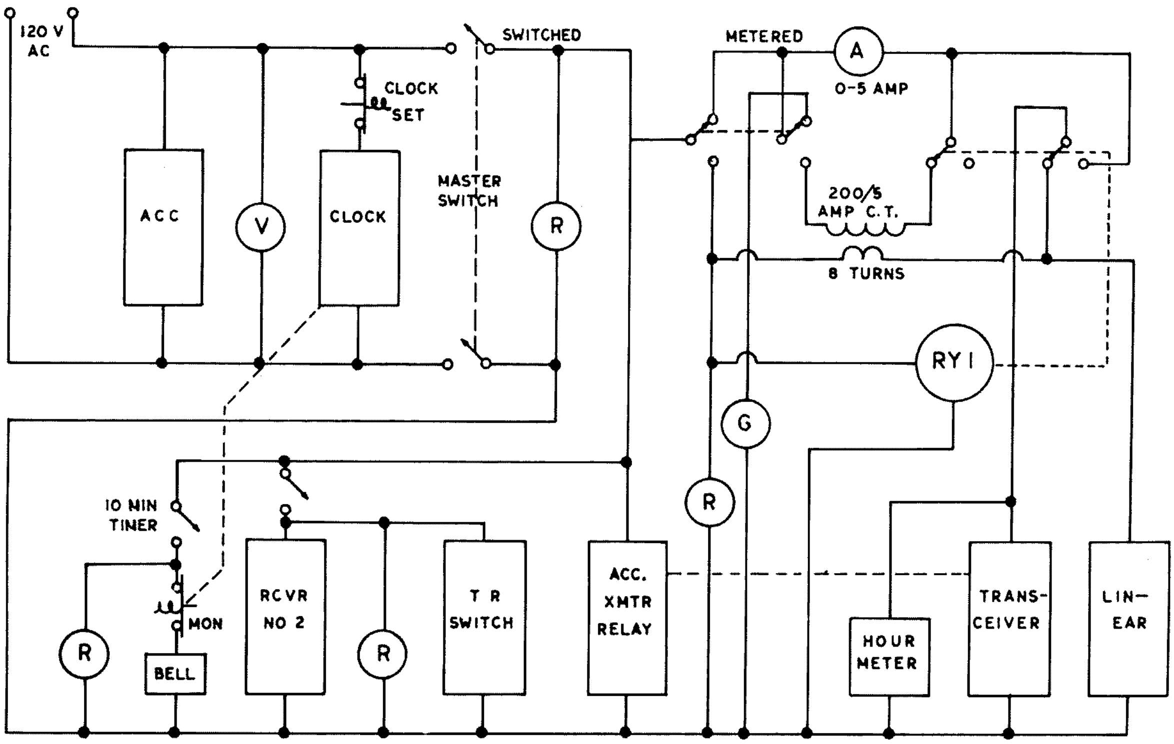


Fig. 1. Complete 120 volt AC wiring.

all applicable codes. The back of the console contains recepticles for the ac lines from the transmitter, receiver, linear etc. It also holds the inputs for mike, telephone and tape recorder as well as an additional relay for muting outboard receivers, lighting "on the air" sign, etc. This relay is operated by an auxiliary contact on the antenna relay on the transceiver. The totalizing hour meter is 110 volt ac surplus and indicates total heater hours on the transmitter. Additional meters may be used to show plate hours, linear heater hours, etc.

Fig. 2 is a block diagram for the *rf* circuit and audio circuits. The coax switch allows any of three antennas or a dummy load to be selected. The audio input selector switch is a three pole, six position rotary type which should be shielded.

The console also includes a mike preamplifier and speech compressor. The telephone dial was mounted on the front panel and the hand set on the side for convenient use. In addition, a hybrid phone patch is installed which can be cut in and out at will. With the patch cut in, the receiver

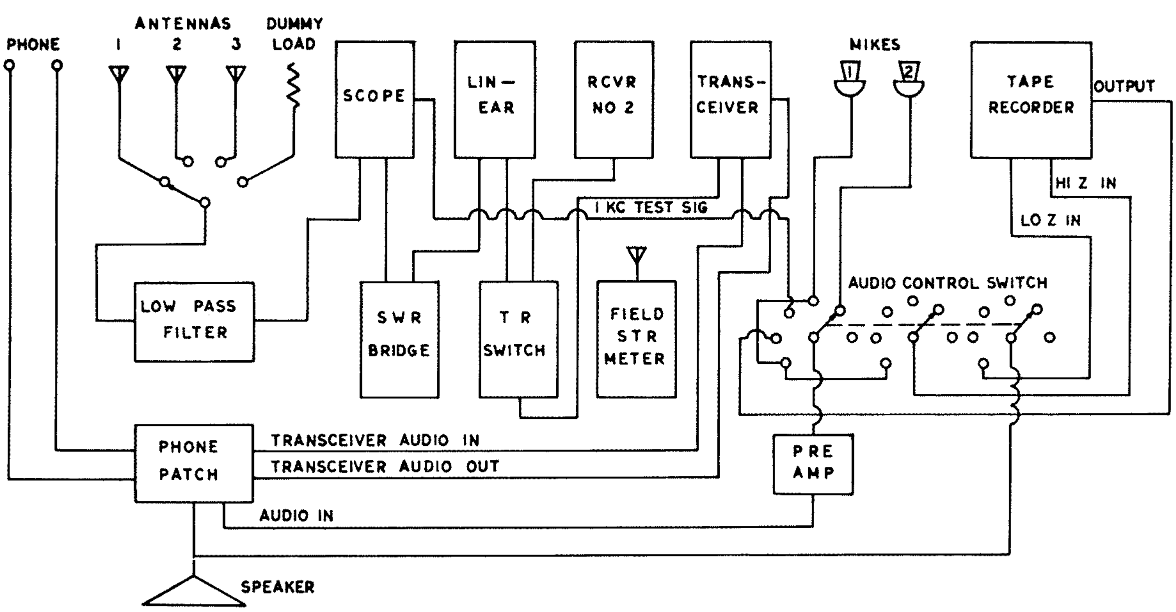


Fig. 2. Block diagram for rf & audio circuits.

speaker is muted, and monitoring is accomplished through the receiver portion of the hand set. The ac switches are rocker type and the pilot lights are inexpensive 110 volt neons. The aluminum panel is easily obtained from surplus. Before mounting the equipment on the panel it can be given a pleasing "brushed" appearance by sanding lightly and spraying with clear acrylic or if desired, painted with a high grade switchboard enamel.

All stations tend to become personalized because of different equipment and individual preferences. This article was written merely to suggest some ideas on approaching the design of a functional console, and details have been purposely omitted. The two factors of operating convenience and pleasing appearance are most important and the author's console has added much real pleasure to operating in addition to bringing admiring glances from visitors to the shack. A construction project of this type is relatively simple and offers much satisfaction for those of us who have a yen to build a part of the equipment in the shack, yet do not feel technically competent to tackle modern transmitter or receiver design and construction.

. . . W6GDP

Rack Those Test Leads

Is your workbench always cluttered up with test leads that somehow seem to get tangled up with everything else? Do you spend more time looking for and then untangling a special test probe or jumper wire than you spend in the actual process of testing or jumping?

If you do, you no longer have to. Just go down to the local drug store or department store and ask one of the employees for an old display rack. These racks hold everything from combs to small packaged items and when all the products on the rack are sold, usually the rack is discarded. But you can use such a rack to store your test leads in a 'civilized' manner. The appearance of your workbench will be 100% neater!

D. E. Hausman VE3BUE

RTTY Autostart

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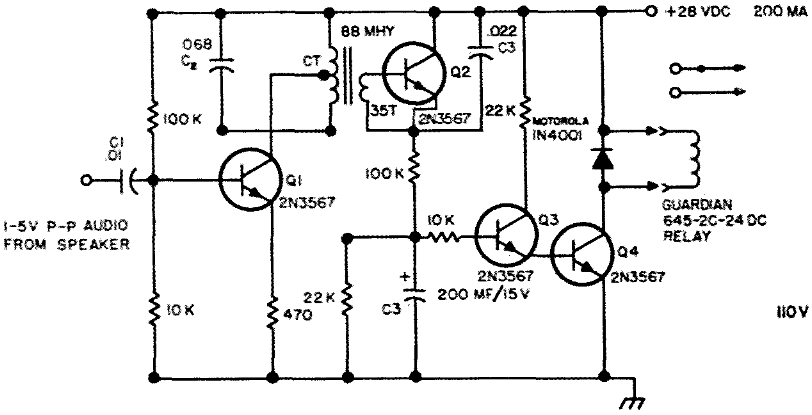

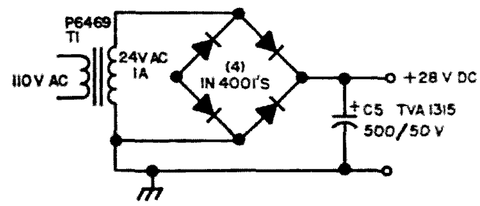

This autostart circuit is versatile in that it connects to the speaker instead of digging into the TU, is solid state and therefore small, and can be hooked up to turn on the teletype machine and TU power. The power supply requirement is +24 to 28 VDC at 10 mA no signal to 200 mA with signal. This autostart was designed originally for monitoring USAF MARS VHF nets where both voice and teletype are used. Many stations operate on VHF and HF SSB simultaneously. With this device it is not necessary to stop copying on HF to turn on the teletype machine. It insures that you receive all RTTY copy on the net.

The first transistor is a tuned amplifier. The input audio must be in the range of 1 to 5 volts peak to peak which is the normal listening range voltage for a 4 to 8 ohm speaker. For a 600 ohm impedance a resitive devider consisting of a 1 k and 10 k resistor or a 600 to 8 ohm transformer must be added. The tuned circuit is resonant to the standard mark frequency of 2125 Hz. Any combination of L and C may be used for other tone frequencies for selective call, etc. The coil is the usual 88 mH toroid available on surplus. Bandwidth is approximately 150 Hz. The .068 capacitor should be a good mylar type for frequency stability. Turns may have to be taken off to get exact resonance for best performance. If the .068 capacitor is close to tolerance, about 35 turns should be taken off. The link couples about one volt at resonance to the switch transistor Q2 which then turns on and allows the 100 mfd capacitors to charge up. When this charging voltage gets up to 1½ volts the relay drivers Q3 and 4 turn on and energize the relay. The 100 k resistor with a 100 ohm relay gives about 3 seconds before turn on. Likewise it takes about 3 seconds to drop out in absence of a steady mark tone. The time out is determined by the relay coil resistance and the 22 k resistor. Both the 100 k and 22 k resistors can be varied for any desired time in and out up to 10 seconds.

Operation

Hook up the input to an audio source of 2125 Hz and take off 5 turns at a time from the hot side of the toroid until maximum voltage is shown on a scope or ac VTVM. Check the time in and out of the relay and change the 100 k and 22 k resistors for the desired length of time. The relay should have 10 amp contacts because of the starting current of the teletype machine.

Construction can be on a chassis, vector or PC board as the circuit is not critical to pickup or capacitive effects as with other types of autostarts. I can supply a PC board for $2.50 or a completed tested unit for $15.00 post paid.

This circuit is great for both the lazy man and the busy man and ensures that you get all the teletype copy on the net.

. . . W6ORG

Oscillator Frequency-Shift Calculations

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It is always of interest, when designing an oscillator, to know how much frequency shift will result from a change in component values, whether intentional or unintentional. A few equations for such calculations are given here.

I. An approximate equation for relative frequency change $\frac{\Delta f}{f}$ caused by a relative capacity change $\frac{\Delta C}{C}$ or a relative inductance change $\frac{\Delta L}{L}$:

$$\frac{\Delta f}{f} = ½ \frac{\Delta C}{C} = ½ \frac{\Delta L}{L}$$

Suppose, for example, that a tuned circuit with C = 100 pF, L = 1.27 uh, f = 14.0 MHz uses a fixed capacitor with a negative temperature coefficient of 750 parts per million per degree Centigrade, and the ambient temperature rises 5° C. The change in capacity is $750 \times 10^{-6} \times 5 \times 100 = 0.375$ pF. The relative change in capacity is $\frac{0.375}{100}$ = 0.00375. The frequency will increase by approximately

$$\Delta f = ½\, f \frac{\Delta C}{C} = ½ \times 14.0 \times 0.00375$$

$$= 0.02625 \text{ MHz} = 26.25 \text{ kHz}$$

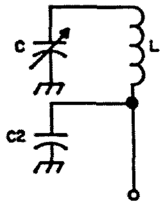


Fig. 1. A bypass capacitor in a tuned circuit.

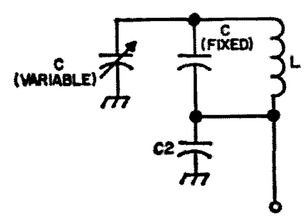


Fig. 2. A fixed capacitor wired on the inductor side of the circuit.

The new resonant frequency will be about 14.026 MHz. Working out an exact answer is long and laborious, and cannot be slide-ruled because of the great accuracy needed for calculating an increase in frequency of less than 0.2%. A more precise result for the new resonant frequency is 14.02633 MHz, virtually identical to the result obtained using the simpler equation.

Conversely, if a zero-temperature-coefficient capacitor is used in the above tuned circuit, and the frequency is observed to drift down 26 kHz when the temperature increases 5° C., substitution of an N750 capacitor will reduce the drift to near zero.

This equation can also be used for rough calculations of the capacitors necessary to tune a given frequency range. Suppose it is desired to tune 7.00-7.30 MHz and a 6-80 pF variable is available. How much fixed capacity is necessary in parallel with the variable to tune the range?

The relative frequency change is $\frac{\Delta f}{f} = \frac{0.300}{7.150} = 0.042$. The relative capacitance change must be twice this, or 0.084. The capacitance change available is 74 pF, so the total capacity at center frequency must be $\frac{74}{0.084} = 882$ pF. Center capacity of the variable is 43 pF, so 882 − 43 = 839 pF is required in parallel with the variable to tune this range.

II. An exact equation for the frequency range tuned by a variable capacitor with capacity range ΔC, or by a variable inductor with inductance range ΔL, is

$$\left[\frac{f_1}{f_2}\right]^2 - 1 = \left[\frac{f_1}{f_2} + 1\right]\left[\frac{f_1}{f_2} - 1\right]$$

$$= \frac{\Delta C}{C_1} = \frac{\Delta L}{L_1}$$

where f_1 = resonant frequency for $C = C_1$ or $L = L_1$ (the higher resonant frequency)

f_2 = resonant frequency for $C = C_1 + \Delta C$ (variable capacity) or $L = L_1 + \Delta L$ (variable inductance)

Taking the example above, with the 6-80 pF variable capacitor for the frequency range 7.00-7.30 MHz, and calculating C_1:

$$\frac{f_1}{f_2} = \frac{7.30}{7.00} = 1.4029$$

$$C_1 = \frac{C}{\left[\frac{f_1}{f_2} + 1\right]\left[\frac{f_1}{f_2} - 1\right]}$$

$$= \frac{74}{(2.0429)\ (0.0429)} = 844 \text{ pF}$$

This is the minimum capacity, for resonating at the higher frequency; allowing for the 6 pF minimum capacity of the variable, 838 pF (less stray capacitances) is required in parallel with the variable.

The close agreement between the calculation with the approximate equation and the exact equation is due in this case to blind luck. For $\frac{\Delta f}{f}$ above a few percent, when accurate results are needed, the exact equation must be used; for very small $\frac{\Delta f}{f}$ or where only approximate results are needed, the simpler equation can be used.

III. Frequently a bypass capacitor is used in a tuned circuit, as in **Fig. 1.** The bypass and the tuning capacitor are effectively in series. How much frequency drift is caused by a variation in the capacity of the bypass? An approximate equation for the net change in capacity of the two capacitors in series is

$$\frac{\Delta C}{C} = \frac{C}{C_2}\left[\frac{\Delta C_2}{C_2}\right]$$

where C = capacity of tuning capacitor (about the same as the net capacity of the capacitors in series)

C_2 = capacity of the bypass capacitor

ΔC_2 = change in C_2.

Suppose that $C = 844$ pF, $f = 7.30$ MHz, and $C_2 = 0.02\ \mu F$ with temperature coefficient 1% per degree Centigrade (typical for general-purpose ceramics). For a temperature rise of 5° C., the change in C_2 is 5%; $\frac{C_2}{C_2} = 0.05$. Then

$$\frac{\Delta C}{C} = \frac{844}{20{,}000} \times 0.05 = 0.00211$$

The first equation of this article can be used to calculate the frequency drift:

$$\Delta f = \tfrac{1}{2} f \frac{\Delta C}{C} = \tfrac{1}{2} \times 7.30 \times 30 \times 0.00211$$

$$= 0.00766 \text{ MHz} = 7.66 \text{ kHz}$$

Since C_2 is increasing, the resonant frequency decreases by 7.66 kHz. Thus the tuned circuit components could be perfect, and the drift would still be excessive for a VFO, because of variation in the bypass capacitor.

This drift can be sharply reduced in this case very easily. The tuning capacitance C is made up of a variable in parallel with an 838 pF fixed capacitor. Suppose the fixed capacitor is wired on the inductor side of the circuit, as in **Fig. 2.** Then the bypass is in series with only the 6-80 pF variable capacitor. At the high-frequency end the variable capacitor contributes only 6 pF and the variation in bypass capacity will be entirely negligible. At the low-frequency end ($f = 7.00$ MHz) the variable is set at 80 pF, and the effective change in capacity for a 5-degree heating as before is

$$\frac{\Delta C}{C} = \frac{80}{20{,}000} \times 0.05 = 0.0002$$

or $\Delta C = 0.0002 \times 80 = 0.016$ pF.

Then, using the first equation for $\frac{\Delta f}{f}$,

$$\Delta f = \tfrac{1}{2} f \frac{\Delta C}{C} = \tfrac{1}{2} \times 7.00 \times \frac{0.016}{(838 + 80)}$$

$$= 6.1 \times 10^{-5} \text{ MHz} = 61 \text{ Hz}$$

The drift is less than a hundredth of what it was with the fixed capacitor on the tuning-capacitor side of the bypass.

Note also that increasing the bypass capacitance with temperature coefficient unchanged decreases the frequency drift. Therefore bypass capacitors for high-stability oscillators should be as large as internal resonances permit.

. . . WA6DPD

Accurate if Alignment

I hear many hams talk of the trouble they have in accurately aligning the *if's* of their receivers, especially some of the newcomers using a converted surplus receiver. I have been using the procedure listed in **Fig. 1** for years, and find that most receivers will come close to reading correctly if the *if's* are set correctly before any *rf* or oscillator alignment.

As all American BC stations use 10 kHz separation and are crystal controlled, I use them to check signal generator settings. For instance, suppose I want to align a receiver with an *if* frequency of 1680 kHz. Setting the signal generator at 420 kHz, its 2nd harmonic should zero beat with a broadcast carrier at 840 kHz. Then its fourth harmonic is within a few cycles of 1680 kHz, and is used for the *if* alignment. To align a 455 kHz *if* accurately, I zero beat the signal generator's second harmonic of 455 kHz against a 910 kHz broadcast carrier, and align from the fundamental.

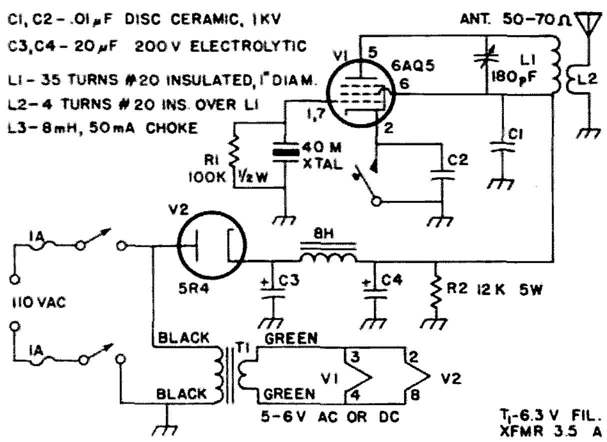
This approach is very accurate, and the signal generator needs a 30 minute warmup before doing alignment work. If the receiver *if* is known to be far off, I do a rough alignment before using the above procedure.

If Freq. of rcvr.	Sig. gen. setting	BC station zero beat at:	Harmonic beat with BC sta.	Harmonic for alignment
260 kHz	260 kHz	780 kHz	3rd	Fund.
262 "	262 "	1310 "	5th	"
266 "	266 "	1330 "	5th	"
455 "	455 "	910 "	2nd	"
915 "	305 "	610 "	2nd	3rd
1650 "	330 "	660 "	2nd	5th
1680 "	420 "	840 "	2nd	4th
1750 "	350 "	700 "	2nd	5th

Harold Mohr K8ZHZ
5670 Taylor Rd.
Gahanna, Ohio 43020

Glenn Ungarten WB2YOJ
1618 Larkspur Dr.
Mountainside, N.J. 07092

A Ten Minute 40 Meter Rig



The rig described here should fill the bill for a standby when the big rig breaks down, or to persue QRP hamming. The transmitter can run about 15 watts on 40 into a 50-70 ohm load. If power is borrowed from another source, all the rig consists of is a tube, a resistor, two capacitors, and a coil. You should be able to build it breadboard style in the time it takes the station receiver to warm up!

The circuit is a simple crystal oscillator making use of the pentode tube. The circuit is tuned by the plate to cathode capacity within the 6AQ5. The final is dipped by permeability tuning of the coil. A similar triode circuit was popular during the '30s using 6L6's, which you old timers may remember.

Start scrounging the parts from old TV's which can be obtained for the asking from service shops. The old sets contain plenty of goodies; a husky power transformer, capacitors, resistors, chokes, a speaker, and some FB tubes.

Almost all of the parts can be found inside a TV set of late vintage. You may have a bit of trouble locating the 6AQ5, but be persistant and you will find one, usually after looking through about half a dozen sets. Because of the low level of *rf*, the socket can be the original ripped out of the set, and not a special porcelain one. While C_1 and C_2 are specified as .01 μF they can be almost any value that your TV set uses for bypassing. Anywhere from .005 μF to .02 μF is fine here. L_1 is wound on a one inch diameter cardboard form and consists of about 35 turns of #20 wire. This amount of inductance is not enough to resonate the circuit at 40 meters, but more inductance is added later by inserting a ferrite rod into the coil. A two inch piece of a loopstick from an old BC radio is ok for this. Wind L_2 directly over L_1, about 25 turns from the hot end. Be sure to wind it in the same direction or you will get a phase shift in the output signal. Twist the ends of L_2 after winding to keep it from unwinding. A tube socket from the television or a similar receptical can be used for the crystal socket. A special crystal socket doesn't seem to be necessary.

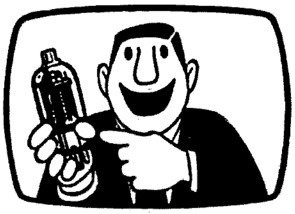
The easiest way to supply power to the rig would be to borrow it from another source. A BC radio, record player, or tape recorder will usually provide about 150 volts of B plus. That's enough to run about two watts input. The power supply I used is of the ac-dc type. The TV should contain a suitable five volt rectifier, choke, and electrolytic capacitors. Check the caps with a VOM to be sure they are not shorted before using them. The choke, L_3 is not critical and can be anything that resembls a choke. You can even use the primary of the TV's speaker output transformer. Bleeder resistor R_1 is also not critical but should be about 100 ohms per volt that the power supply will handle. Be sure that R_2 is conservatively rated, because a blown bleeder resistor is more dangerous than none at all. Also, if you use an ac-dc power supply don't try to connect it to an earth ground or use a VFO with a grounded shield on its output. If you do, stock upon plenty of fuses for your house.

To put the transmitter on the air, hook one side of L_2 to a 50-70 ohm antenna. Plug it in and give it the smoke test. If

everything is ok, insert the ferrite rod into the coil and tune for a dip on a 0-50 mA meter connected at point "X". Tape a cardboard arm about four inches long to the ferrite rod so the final can be dipped without being detuned by your hand. The current at resonance will be between 10 and 40 mA, depending on the B plus voltage.

Running about one watt input on 40 meters to a dipole here in two-land, I can work four and nines nightly, and occasionally a zero. I have really been surprised at the performance of my li'l rig, as I know you will be.

...WB2YOJ



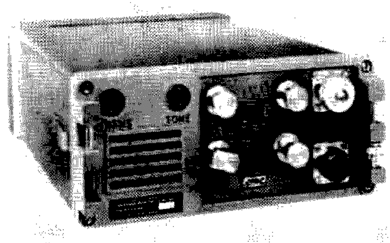
NEW PRODUCTS

Amphenol Hobby Booklet

A nice photo, and look again. This is 15-year-old Barry Meyer of Park Forest, Ill., assembling a SWR bridge. But there in the foreground are an Amphenol blister-pak RF-58A/U coax fitting (with assembly data on the back of the package) and, under the pliers, a copy of Amphenol's new hobbyist booklet.

This booklet is a handy reference guide, to be used and kept on the workbench. It contains information on how to solder, interpret schematic symbols, read resistor color codes, etc.

Ask at your distributor's for the Amphenol Blister-Paks, which are being used as packaging for a wide variety of components. And you can get one of the workbench guides by sending a self-addressed stamped envelope to "How-To Handbook," Amphenol Distributor Division, The Bunker-Ramo Corporation, 2875 S. 25th Ave., Broadview, Ill. 60153



Very Portable Transceiver

A rugged new transceiver should be very useful for groups needing emergency transceiver facilities. The Kaar Electronics Corporation has introduced an all-solid-state SSB/CW transceiver for shoulder-pack or fixed location communications work. Rated at 10 watts PEP, the transceiver can be operated from D-size heavy-duty cells, from a 12-volt dc car or battery system, or through an adapter from an ac power line. Receive and transmit frequencies are crystal-controlled in the 20, 40, 80 or 160 meter bands.

For details on their Kaar ComPact 24, write the Kaar Electronics Corporation, 1203 W. St. Georges Ave., Linden, N.J. 07036.

New Books from Sams

Sams has announced several new and reprint books for electronics workers.

ABC's of Electronic Test Equipment, by Donald Smith, ($2.95) is out as a 2nd edition. This is a basic text with information on VOM's, VTVM's, component testers, signal generators and tracers, oscilloscopes, multiples and color bar generators, and other instruments. Sams #20660.

A new title, Practical Design with Transistors, by Mannie Horowitz ($5.95) uses the direct approach to designing biasing, feedback and high-frequency circuits, and includes data on recent semiconductor developments and new FET applications. Sams #20659.

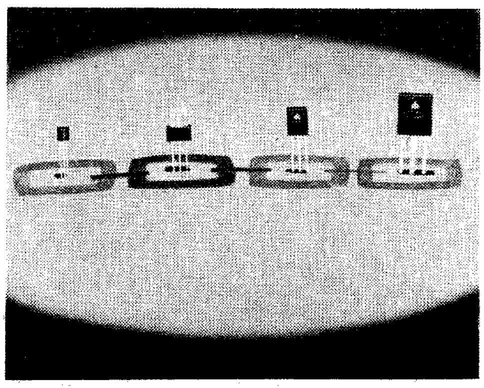
Using Scopes in Transistor Circuits, by Robert G. Midleton ($4.95) includes waveform discussions and solid state circuit theory relevant to oscillators, amplifiers, waveshaping circuits, and monochrome and color TV, and electronic computers. Sams #20662.

Robert M. Brown's 101 Easy CB Projects ($3.25) describes an entertaining collection

of simple, practical CB projects. Parts lists and construction details are included. Sams #20663.

The North American Radio-TV Station Guide, by Vane A. Jones, ($2.95) appears in a new 5th edition. Listings include frequencies, call letters, locations, and network affiliations, and other data for AM, FM, and TV stations in the U.S., Canada, Cuba, Mexico, and the West Indies. Over 9500 assorted stations are listed. Sams #20635.

Write to R. R. Fleck, Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, Indiana 46268 for further information. Try your distributors' too, since the books may already be there.



Motorola Uniwatt Transistors

Here are some new transistors to fill in the gap between little transistors and big transistors. Medium-size transistors.

Motorola's new Uniwatt transistors can dissipate up to 1 watt in air, or eight watts into a well-designed heat sink. All are silicon annular transistors, offering good high-frequency response. They are encased in plastic packages, with a copper tab for heat-sinking. See second from left in the photo.

Prices are quite low, and get up over a dollar for some of the Uniwatt transistors. For more information write to the Technical Information Center, Motorola Semiconductor Products, Inc., Box 20924, Phoenix, Arizona 85036.

The VHF Amateur

This informal, well-illustrated book is based upon Robert Brown's magazine "The VHF Amateur," which was the only monthly VHF magazine for a period of five years. Also titled "The VHF Amateur," the book

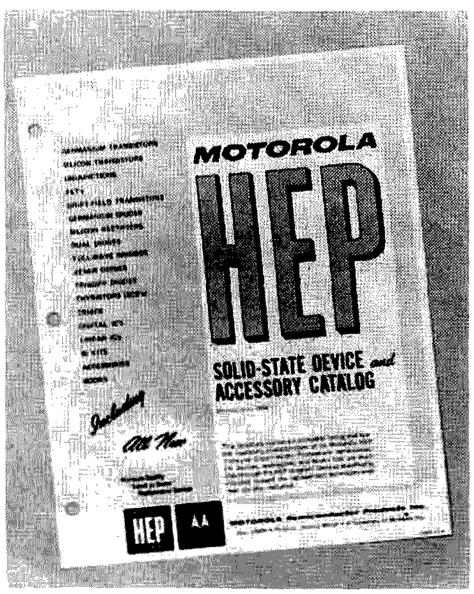
contains several projects from the magazine including some unusual antenna systems and details on two surface-wave transmission lines. This is the arrangement sometimes known as the "G-string."

Several pages are devoted to the construction of two styles of pen recorders, which are useful for moonbounce and space communications experiments. Some of the problems of antenna tilting are discussed also.

The popular Heathkit "Twoer" comes in for a discussion of possible further circuit development, and there are some notes on APX-6 conversion.

Other material includes schematics of TV tuners that may be converted for VHF applications, a very inexpensive 2-meter receiver, a 2-meter sideband transmitter and several other VHF projects.

Available from distributors or from Editors and Engineers Ltd., New Augusta, Indiana for $4.50.



New Motorola Catalog

Motorloa's large HEP line is still growing. Now it is up to 175 assorted devices, all listed in Motorola's latest HEP catalog. The listing includes many new entries of power, complimentary, and high-voltage transistors; a unijunction transistor, new integrated circuits, and several other items.

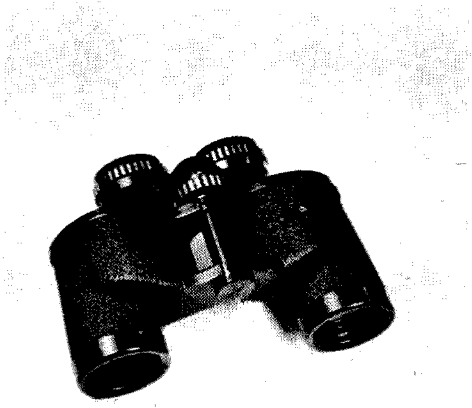
The new catalog also carries a list of "Equal-or-Better" replacement rectifiers, zeners, and transistors. Ask for Motorola's HEP catalog, MHA27-4, from any of the more than 1100 HEP distributors, or from the Technical Information Center, Motorola Semiconductor Products Inc., PO Box 20924, Phoenix, Arizona 85036.

Omega-T Bridge

A radio antenna is something like an appliance plug you push into a wall socket when you want line power for a light or an iron. It has to fit, but the critical electrical sizes for the radio antenna are not visible to the eye.

Many simple and complex electronic instruments are marketed for antenna testing. Basically, they all do the same job, indicating when the antenna is properly adjusted. Most of them require additional instruments, and for some a transmitter is needed too. But here is an instrument that gets by with only the gear that will be available anyway: the antenna, and the receiver that is to be used with the antenna.

The Omega-T Bridge circuitry does the rest of the job. There is quite a lot of it inside that little box, which accounts for its price. This excellent investment will be valued by any worker who is trying to get the best performance from a transmitting or a receiving antenna. This recently developed improved model antenna bridge noise bridge is now available at $34.95 from Omega T Systems, Inc., 516 W. Belt Line Rd., Richardon, Texas 75080.



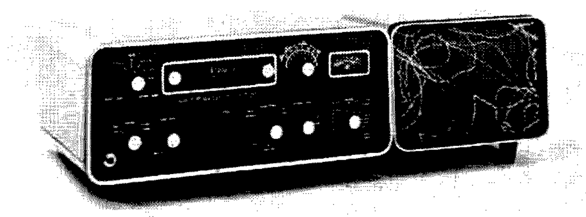
Micronta Binoculars

If you want to see what's going on up there in your tower, you can always pick up a handy pair of binoculars and look if you can find some binoculars.

Radio Shack has introduced a line of low-priced binoculars that are available in three varieties: normal, wide angle, and extra wide angle. All are the same magnification and size, 7 x 35, but offer fields 341, 525 and 578 feet wide respectively at 1000 yards.

The binoculars are available nationwide from Radio Shack's more than 340 outlets. They feature hard-coated lenses, aluminum frames and fast center focusing. All come complete with carrying case, wrist safety strap, and lens caps.

Priced at $19.95, $24.95, and $29.95 (for the widest field) the binoculars may be obtained from Radio Shack, 730 Commonwealth Ave., Boston, Mass. 02215 if they are not available locally.



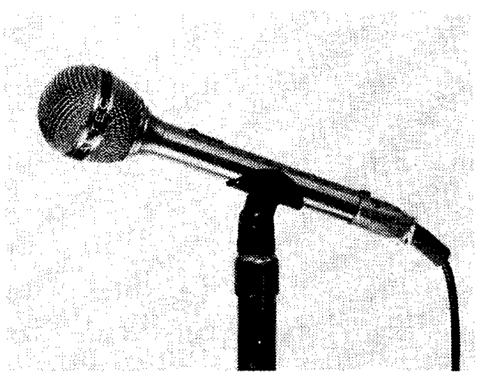
Hammarlund HQ-215 Receiver

The first fully-transistorized amateur receiver built to work with a matching solid-state transmitter. Hammarlund's HQ-215 is currently being shipped to distributors.

Technical features include modularized circuit design, and a unique carousel-type

dial with 22 inches of scale for a dial accuracy of plus/minus 200 cycles. Sensitivity is better than 0.5 microvolts for a 10 db signal to signal-plus-noise ratio. The HQ-215 uses 26 silicon transistors, 13 diodes and two zener regulators. It is supplied with one 2.1 kHz filter and has provision for two more.

Price is $529.50 with a matching speaker at $24.95. For further information write to Irving Strauber, W4KXD, Hammarlund Manufacturing Co., Mars Hill, North Carolina 28754

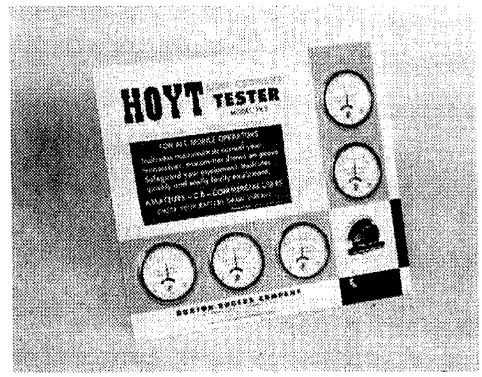


Response Tailored Microphone

Modern electronic devices and circuits tend to be inherently wideband. Additional circuit components are often required to reduce frequency response to that appropriate for most effective communications, but an alternative is to avoid introducing the unwanted frequencies into the circuit at all.

Altec Lansing's Model 650A cardioid dynamic microphone is specially designed for a limited frequency response. Its high frequency cutoff is fixed at 14 kHz, but the low-frequency response can be switched to either 50 or 400 Hz. And its cardioid response feature makes it far less susceptible than ordinary microphones to picking up interference and unwanted crowd noises originating from the side opposite the speaker. Front to back discrimination is 20 db.

The amateur net price is $75.00. For further details write to Don Palmquist, Altec Lansing, 1515 South Manchester Ave., Anaheim, Calif. 92803.

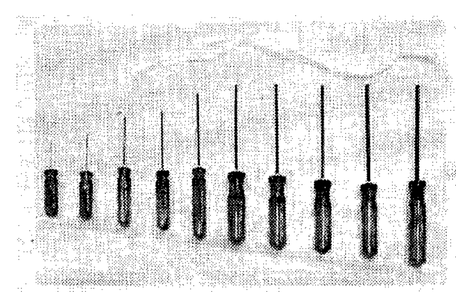


Hoyt DC Current Gauge

A part of good planning in mobile rig installation is to be sure where all the generator currents are flowing, and to know what the various operating currents really are. A conservative generator designer may have allowed no more than enough capacity for your rig, or perhaps somehow the battery runs down too much and it is not very clear what the trouble is. Such questions are best answered by measurements, but it may be difficult to break into the circuit at several different points. Hoyt's new current test meter makes this surgery unnecessary.

This convenient induction indicator responds to the magnetic field around a wire carrying up to 30 amperes. It will give a usable response to as little as one or two amperes, and indicates either direction of current flow. Without any cutting, you simply hold the meter against the wire.

Supplied five to the display card. Try your distributor for radio or automotive supplies, or write to the Burton-Rogers Co., 42 Carleton St., Cambridge, Mass. 02142.



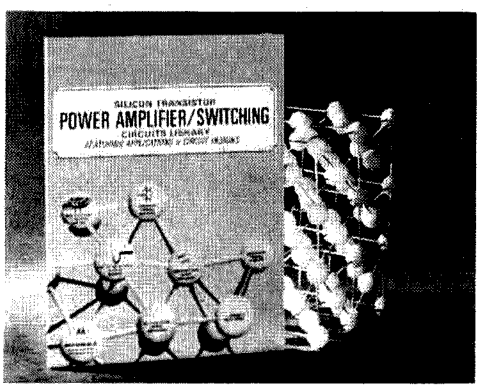
Small Tools

Hunter Industries is manufacturing a complete line of small and special-purpose tools for electronics assembly work. Some of these tools resemble but are imaginatively different from those you might find in your hardware store. For instance, the simple hex screwdrivers pictured above are not very

generally available, yet any bench worker knows hex nuts are pretty common in electronics gear. Think about having a set of hex drivers in your lab, and then write to Hunter Industries, 9851 Alburtis Ave., Santa Fe Springs, Calif. 90670.

Motorola Condensed Catalog

Motorola Semiconductors' new 1968 Condensed Catalog is an excellent hunting ground for bench-working hams looking for news about new semiconductor devices. It will be very interesting to electronics writers, too. It contains major specs on more than 3500 of Motorola's semiconductor types, and order information on about 9000 more. Semiconductor device mechanical dimensions are also given. Write to Department TIC, Motorola Semiconductor Products Inc., Box 13408, Phoenix, Arizona 85002.



Power Transistors Book

The growing importance of power transistor technology is becoming apparent in the higher-power and higher-frequency specs continually appearing in the engineering publications. Now Motorola has published an eighteen-section volume of technical literature describing applications for silicon power transistors.

Consumer and industrial applications are discussed, and the material is directed to users with less deep technical knowledge as well as to the trained engineer. A Selection Guide covers about 100 plastic and metal transistor types ranging from 3.75 watts to 200 watts dissipation.

From Motorola Semiconductor Products Inc., Box 955, Phoenix, Arizona.

Sudden UFO Interest Not Restricted To Hams

Ken W. Sessions, Jr. K6MVH
Technical Editor
Electro-Optical Systems, Inc.
300 N. Halstead
Pasadena, California

The radio amateur's interest in flying saucers may be more timely than one might at first suspect, for a similar interest was recently announced in Russia, a country with an earned record of ignoring such space phenomena. And when Russia takes a look at the world of flying saucers, that IS news! In what amounts to a complete reversal of official attitude toward flying saucers, Russia now rejects the tired explanations we Americans are accustomed to hearing: that UFO's are the result of "optical phenomena" and that they are quasi-natural occurrences of atmospheric or terrestrial origin. Russian scientists now go on record as offering their learned support to the hypothesis that UFO's originate on at least one other world somewhere in space.

In articles appearing in "Kimsomol'skaya pravda" and 'Teknika-Molodezhi," the Russian scientific community let pass a sequence of startling announcements that tend to confirm the need for a world-wide amateur radio "skywatch" plan. Included was a convincing conjecture that the famed Tungusky meteorite of 1908 was an artificial craft from another planet.

Information as to the contents of the two Russian scientific publications was released by Electro-Optical Systems, Inc., an aerospace firm in Pasadena, California, in a house-organ series entitled "Soviet Science in the News." The California firm, a subsidiary of the Xerox Corporation, makes regular translations of Soviet technical papers as a service to American scientists.

According to the Russian-to-English translation of the Soviet papers, there has been a number of recent Soviet investigations by the USSR's Academy of Sciences with respect to the Tungusky meteorite. The Tungusky explosion, the report said, had every parameter of an atmospheric nuclear blast and left considerable residual radioactivity. Also lending credence to the Soviet Academy's theory was the fact that the "meteorite" had apparently maneuvered immediately preceding the blast. The mysterious body exploded after apparently negotiating a 375-mile arc in the earth's atmosphere.

While the Russian's sudden interest in UFO's as a very real element of our times does not necessarily mean all old theories must be discarded, it does help to maintain an aura of sobriety in the discussion of a subject once reserved for the lunatic fringe.

. . . K6MVH

Around The World

Algeria

Although the amount of equipment available is very limited as a result of strict regulations and an embargo on sending money out of the country, more licenses are expected to be issued shortly. At the present time there are 15 licensed stations in Algeria, seven held by nationals (7X2), five by foreigners (7X0), and three by club stations (7X2 plus three letters).

Five stations are active on 144 MHz, working into France, Italy and Spain. There is interest in SSB, RTTY and TV, but the equipment is just not available.

Bulgaria

During November a 15 day seminar was held in Sofia for instructors in Amateur Radio in order to help them improve their methods of teaching the theory of electronics. Operating practices for VHF and short wave, contest operating, construction practice, fox-hunting and the organization, conducting and judging of competitions were also discussed.

In December each of the 32 District Radio Clubs met in Sofia for a 15 day course on fox-hunting. Each participant had to build three fox-hunting transmitters for 3.5 and 144 MHz.

A special Jubilee International LZ DX Contest will be held on September 14, 1969 from 0000 to 1200 GMT on CW and SSB to mark the 25th anniversary of the Republic.

ITU–Geneva

The Administrative Council of the ITU has announced the intention to hold a World Administrative Conference in the latter part of 1970 to deal specifically with Space Radio Communications, Problems and Allocations. The exact dates, location and detailed agenda will be decided by the Council in May 1969.

Faroes

The annual meeting of the FRA was held in Thorshaven in October 1968. An activity contest was announced starting 1 Nov and ending 30 April 1969 on all bands, 3.5 to 28 MHz.

Italy

Radio manufacturers and dealers in Italy are required by law to provide purchasers of radio transmitters with a government certificate setting out the frequencies on which the transmitter may be operated and the maximum power that may be used. Just how this will affect home made equipment is not yet known. The small 11 meter Japanese walkie-talkies may give the authorities fits since many of them run well over the 10 mw permitted by law.

The ARI has petitioned their PTT for permission to operate in the 431.75-432.25 MHz band.

Netherlands

The Netherlands Government has extended its reciprocal operating agreement with the U.S. to include Surinam (PZ) and the Netherland Antilles (PJ), as well as the homeland.

Every Friday evening at 2030 GMT VERON transmits a broadcast in English on 14.1 MHz on RTTY. Reports will be appreciated.

Nigeria

The war with Biafra has held up the issuance of new amateur licenses. At present only stations in Lagos, Kaduna and Zaria can operate. Four members of the NARS are on the staff of the university at Zaria and a strong effort is being made to encourage students to take up amateur radio as a hobby. The SSB station at the university is 5N2AAU and is active.

Norway

The annual meeting of the NRRL took place in August. There are 2379 licensed amateurs in Norway, 258 more than the previous year.

A fund has been set up, with the aid of a government grant of $2100, to help the handicapped to become radio amateurs. IRC's for contacts with LG5LG will also go to this fund. This station has been set up in the Free State of Morokulien, an area surrounding the Peace Monument set up on the Norwegian-Swedish border. Send 3 IRC's for QSL or 4 IRC's for a direct QSL. Send $3.50 for an Honorary Citizenship in the Free State of Morokulien to the NRRL, Box 21, Refstad, Oslo 5, Norway.

Lawrence B. Medwin WB2YRQ
35 Crescent Drive
Whippany, N.J. 07981

Quick and Easy QRP

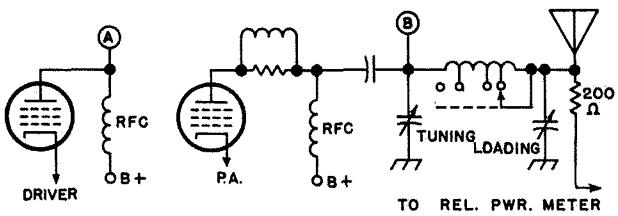


Fig. 1. External conversion of a VFO by adding an antenna coupler, a relative power output meter, and a TR switch.

Nearly every month one sees articles in ham magazines about some low power transistor transmitter. Have you ever had a desire to build such a rig but never got around to winding the coils or sending away for the transistors? But your laziness (and mine!) shouldn't stop you from enjoying QRP operations. This article describes two simple ways of using equipment in your shack to get you on QRP in a single evening.

In Method I a VFO is converted (externally) by adding an antenna coupler, a relative power output meter, and TR switch (See **Fig. 1**). If you don't have a separate VFO, Method II describes conversion of a medium power transmitter by removing the finals and connecting the driver to the pi-net (**Fig. 2**). I don't recommend crystal controlled low power operation, but it must be possible.

The modern VFO is actually a low power transmitter. It provides a fundamental on 80 and 40 meters and harmonics on 20, 15, and 10. It can be keyed from a terminal strip or jack on the back. The *rf* output is carried out through coax to the transmitter, or in this case, the antenna. The *rf* passes through a harmonic filter-antenna coupler, which consists of a tuned circuit LI-CL. LI is 30 turns of enameled wire, hook up close-wound on a 1 inch diameter cardboard tube. 13 turns are shorted out for 40 meters by SI. C1 was a 100 pF variable, but a standard 365 pF variable will do, though tuning will be a little more difficult.

The relative power output meter is fairly standard. The 5K pot, the sensitivity control, limits the amount of *rf* to the rectifier and filter. CI is tuned for maximum indication on the milliameter. Keep the reading low, as the current you read on the meter is not reaching the antenna.

With this setup, using an HA-5 VFO running five watts input,, I have worked into PEI (579) and Michigan (569); each over 700 miles away. Don't expect fantastic reports, but expect to get out. The number one requirement for QRP work is patience. You will probably not get an answer the first time, or even the second time. It takes a good ham at the other end to even bother to copy your station.

Remember that if your neighbor is running 100 watts,, medium power, you are 13 db below him to start, a little over 2 S units. Don't lose any power in your coax or dipole. My dipole, left over from my novice days, was resonant at about 7175 kHz. As this frequency was approached from the low end of 40 the relative output meter nearly doubled it's reading.

Also of prime importance is your receiver. If you want someone to copy you out of the noise, you must be able to do the same.

And just a word about operating. I wouldn't recommend sending CQ too much. It's better to come back to a CQ right where you can be easily found.

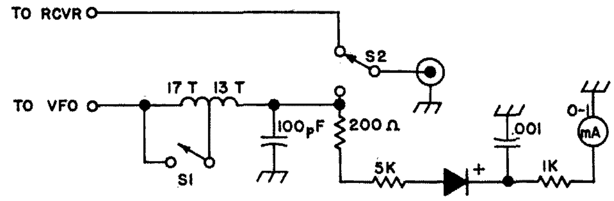


Fig. 2. Conversion of a medium power transmitter by removing the finals and connecting the driver to the pi-net.

Fig. 2 shows the final stage of a CW transmitter. Remove that big, ugly final. Connect a 1000 pF mica capacitor from the point A (the plate pin of the driver) to point B (the input of the pi-net). Since you can no longer tune up by plate current, you must add the relative power output meter circuit, or, in the case of a rig that already has one (like the T150A, which I modified), increase it's sensitivity. This can be done by decreasing the value of the dropping resistor that goes to the antenna jack to about 500 ohms. If the meter circuit is to be added connect the 200 ohm resistor as close as possible to the antenna, and bring a pair of twisted wires out to the pot.

This method offers the advantage of working all bands. Fifteen meters is an especially good band for low power. With fifteen watts input in a T150A I was 599 in Texas, about 2200 miles away. But 15 watts is high power.

Just a few more things. QRP offers a new challenge to hams. Like DXing, which is all it really is (though I've ragchewed for over an hour while my lunch was rapidly cooling) the antenna system must be perfect, for best results. Extreme patience is required, as well as a stable, selective receiver, and a good operator.

If you've ever had any TVI complaints, you won't now. Your rig is no longer strong enough to interfere!

A kindly OM was down at the shack the other day, and, being favorably impressed, made the following encouraging comment: "Why don't you plate-modulate the VFO? Take an audio transformer, hook it up backwards to the hifi, put the primary in series with the B+ to the plate of your final, and . . . He hasn't been invited back.

. . .WB2YRQ

Propagation Chart

January, 1969

ISSUED OCT. 1

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7	7	7	7	7	7	7A	14A	21A	21A
ARGENTINA	14	14	14	7A	7A	7	14A	21A	21A	21A	21A	21A
AUSTRALIA	21A	14	7B	7B	7B	7B	7B	14B	14A	14A	21A	21A
CANAL ZONE	14A	14	7A	7	7	7	14	21A	28	28	21A	21
ENGLAND	7	7	7	7	7	7B	14A	28	28	21	14	7B
HAWAII	21A	14	7B	7	7	7	7	7B	14	21A	28	28
INDIA	7	7	7B	7B	7B	7B	14	14A	14	7B	7B	7B
JAPAN	14	14	7B	7B	7	7	7	7B	7B	7B	7B	14
MEXICO	14	14	7	7	7	7	7A	14A	21A	28	21A	21A
PHILIPPINES	14	14	7B	7B	7B	7B	7	14B	7B	7B	7B	7B
PUERTO RICO	14	7	7	7	7	7	14	21A	21A	21A	21	21
SOUTH AFRICA	14	7	7	7	7B	14	21	28	28	21A	21A	21
U. S. S. R.	7	7	7	7	7	7B	14	21A	14	7B	7B	7
WEST COAST	21	14	7	7	7	7	7	14	21A	28	28	28

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	7	7	7A	14A	21A	28
ARGENTINA	21	14	14	7A	7A	7	14	21A	21A	21A	21A	21A
AUSTRALIA	21A	14	14	7B	7B	7B	7B	7B	14A	14A	21A	21A
CANAL ZONE	21	14	14	7A	7A	7	14	21A	28	28	28	21A
ENGLAND	7B	7	7	7	7	7	7B	14A	21A	21	14	7B
HAWAII	21A	14	14	7	7	7	7	7	14A	21A	28	28
INDIA	7B	14	7B	7B	7B	7B	7B	7B	14	7B	7B	7B
JAPAN	21	14	7B	7B	7B	7	7	7	7B	7B	7B	14
MEXICO	14A	14	7	7	7	7	7	14	21A	21A	21	21
PHILIPPINES	21A	14	7B	7B	7B	7B	7	7	7B	7B	7B	14
PUERTO RICO	14	14	7	7	7	7	14	21A	21A	21A	21A	21
SOUTH AFRICA	14	14B	7	7	7B	7B	14	21A	28	28	28	21
U. S. S. R.	7B	7	7	7	7	7B	7B	14	14	7B	7B	7B

WESTERN UNITED STATES TO:

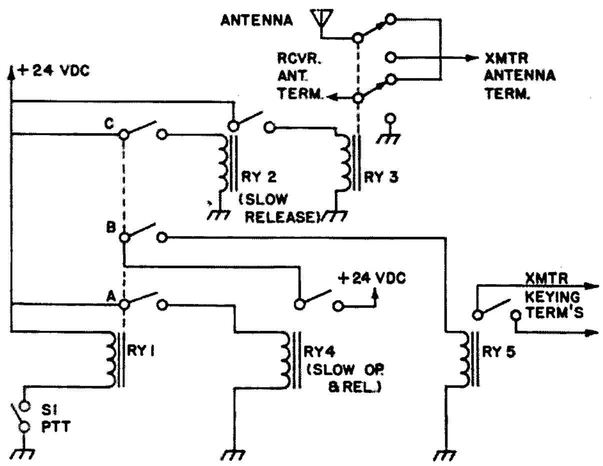
GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	3A	7	7	3A	7	14	21	21A
ARGENTINA	21	14	14	7A	7A	7	7	14A	21A	21A	21A	21A
AUSTRALIA	21A	21A	14	14	7	7	7	7	14	14A	21	21
CANAL ZONE	21	14	14	7	7	7	7	14A	28	28	28	21A
ENGLAND	7B	7	7	7	7	7	7B	7B	14A	14A	14	7B
HAWAII	28	21A	14	14	7	7	7	7	14	21A	28	28
INDIA	7B	14A	7B	7B	7B	7B	7B	7	7	7B	7B	7B
JAPAN	28	21	14	7	7	7	7	7	7	7B	14B	21
MEXICO	21	14	7	7	7	7	7	14	21A	28	28	21A
PHILIPPINES	21A	21	14	7B	7B	7B	7B	7	7	14B	7B	14
PUERTO RICO	21	14	14	7	7	7	7	14A	21A	21A	21A	21A
SOUTH AFRICA	14	14B	7	7	7B	7B	7B	14	21A	21A	21A	21
U. S. S. R.	7B	7	7	7	7	7B	7B	7B	14	7B	7B	7B
EAST COAST	21	14	7	7	7	7	7	14	21A	28	28	28

A - Next higher frequency may be useful also.
B - Difficult circuit this period.

Good: 1, 2, 4-6, 9-12, 14, 16-18, 23-25, 27-30
Fair: 3, 8, 13, 15, 21, 22, 26
Poor: 7, 19, 20

Douglas Byrne G3KPO
Jersey House
Peterborough, England

Full Sequential Switching with Simple Relays



Low-noise transistors in receiver front-ends are mighty fine and have a long, carefree life-provided, and only provided, they are not given a knockout blow from the transmitter rf.

This is all too easy to do at many amateur stations, and for absolute safety it is vital for the control-system to incorporate some form of sequential switching.

Good designs have been published, for instance "Ultimate Station Control" by W2AJW in 73 for Sept. 66, but most involve the use of many transistors or scarce high-resistance relays—and by Murphy's Law, the special type required is never available.

However, there are plenty of surplus 24-volt relays in all self-respecting junk-boxes, and this particular station control-system uses nothing else. In spite of its obvious simplicity, it gives full sequential switching, thereby automatically protecting those expensive front end transistors by making sure the receiver input is grounded and the antenna transferred to the transmitter well before the B-plus is applied to the PA final. And just as important, it sees to it that the B-plus is switched off before the antenna is returned to the receiver input.

Additional advantages are that all antenna switching is done "cold", without rf on the feeders, the transmitter output is always looking into a load, and when the control system is off, the antenna is connected to the receiver—all ready for a quick listen round the bands.

Details of relays

The relays required all have normal sets of contacts, which are "open" in the de-energised position.

RY1, which is the main control, has three such pairs (plus any additional ones which might be useful for killing the receiver B-plus).

RY2 is slugged with a copper ring round the heel or bottom end, as in **Fig. 2a,** and this causes it to be slow to release. If you do not happen to have one of this type around, quit worrying. Simply connect a small diode rectifier across the relay coil—the right way round as in **Fig. 3a,** so that it merely short-circuits the induced EMF, and not the applied voltage. Alternately, wire a resistor across the coil—about the same value as that of the coil—as **Fig. 3b.** Either will delay the release when put across an ordinary relay.

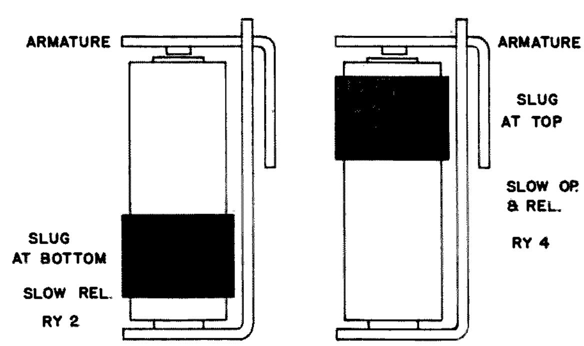


Fig. 2. See Text.

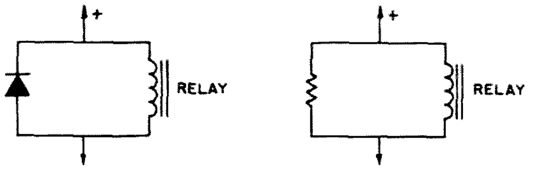


Fig. 3. See Text.

VY3 is the usual transmitter antenna changeover relay.

RY4 is another slugged type, but this time with the copper ring at the toe or top end —next the armature. This makes it slow to operate as well as to release. See **Fig. 2b.**

Finally, RY5 is the transmitter B-plus relay.

Modus operandi

S1, the PTT switch, activates RY1, and current is fed via the "A" contacts to RY2, which closes immediately as it is only slugged for delay on release. So RY3, the antenna change-over relay, is energised without any appreciable time lapse. Receiver input is grounded, and antenna switched to transmitter.

Current is also fed via the "C" contacts on RY1 to RY4, which is slugged to give a time delay in both operate and release modes. So here is there is a time lag before current is fed via the "B" contacts on RY1 to RY5—to turn on the transmitter B-plus.

In the reverse action, S1 is opened, RY1 de-energised, voltage removed from RY2, but —as this has a delayed release—it keeps its contacts closed for a short space of time. So current is still supplied to RY3, and the antenna remains switched to the transmitter for a little while.

Now, although RY4 is slugged and so has a delayed action, the supply of current to RY5 is via the contacts "b" on RY1. And these open immediately after S1 is opened, so the B-plus is removed from the transmitter before the antenna is switched over to the receiver. Result is safety, and long life to your expensive front-end transistors!

. . .G3KPO.

Report on the Drake R-4A Receiver and T-4X Transmitter

Fred W. Fetner, Jr. WB4EFA
1728 *Ebenport Road*
Rock Hill, S.C. 29730

After getting off to a bad start with an inexpensive receiver which proved to be unsatisfactory, I decided to purchase a really good receiver. For some time I studied the specifications of the available receivers but overlooked the Drake for some unknown reason. One day, I read the specifications of the Drake Receiver and was astonished by its many features. After much comparison with other receivers I found that I could find no other receiver at any price with all of the following features:

1. Permeability tuning
2. Transistorized VFO
3. Passband Tuning
4. Crystal lattice filter in first *if* stage
5. Highly selective and adjustable tuned circuits in 2nd *if* stage.
6. Noise blanker as standard (not optional) equipment (not merely a noise limiter)
7. 1 kHz tuning accuracy
8. Notch filter
9. Auxilary band coverage capabilities

I bought my R-4A in April 1967 and was immediately impressed by its good appearance which somehow is not done justice by the catalog pictures of it. I also noticed its extreme quietness. The stability is remarkable. No drift has ever been detected even from a cold start. My homemade CW crystal controlled transmitter has more drift than the R-4A. No retuning has ever been needed. The skirt selectivity is amazing with any normal S-9 signal more than 1 kHz away being inaudible. After using the receiver for a while I began to wonder if the unit was more selective than the standard communications receiver employing a sharp CW crystal filter. So I got such a receiver on loan and used it and found that while it had a very pronounced peak the skirt selectivity was not nearly as good as that of the R-4A and that overall the R-4A was vastly superior and more selective, and much easier to tune.

The Drake has passband tuning which makes it superior to any receiver which does not have this feature. This is an adjustable or tunable circuit in the 2nd *if* stage which may be tuned over a 6 kHz range. The receiver frequency is not changed by the passband tuning control, the control merely selects and peaks the desired frequency out of the 6 kHz wide signal which comes through the crystal filter in the first *if* stage. The lattice filter provides the immunization against cross modulation from nearby powerful stations, and the skirt selectivity and the passband tuning system provides the actual main selectivity which is adjustable from 4.8 kHz to .4 kHz in four steps. 2.4 kHz and 1.2 kHz is provided for SSB use. Upper or lower sideband selection is also made with the passband tuning control. The control can be used to select any one of several stations near the same frequency without having to move the main tuning knob. There is little chance of losing a signal on CW since once the station is heard, the main tuning can be left unmoved and the signal peaked by using the passband control. No variable BFO is used, and none needed, since after peaking one signal all further signals come in at the same audio pitch. By using the high selectivity, Effective T notch filter and switching to the opposite sideband, if necessary, it is rare indeed that a station cannot be copied through QRM. Many times my contacts have referred to QRM on their end and I have replied that they are 599 with no QRM. Some of this is due to the different locations, but most of it is due to the selectivity of the receiver.

The noise blanker eliminates most man-made type interferrence completely but has little effect upon static. Setting the T notch

filter slightly off to one side of the desired signal helps somewhat in copying under heavy static conditions.

Turning the passband control to the center position or slightly to one side of center makes weak CW signals come in stronger and for extreme QRM conditions setting the control toward the extreme right or left position increases the selectivity while making the receiver less sensitive. For SSB the 2.4 kHz position is provided and for extreme QRM conditions the 1.2 kHz position works wonders.

The main dial is marked in 25 kHz increments and a skirt on the main tuning knob is marked in 0 to 25 kHz increments. The claimed accuracy is within 1 kHz across the dial but I have found it to be better than claimed. The calibration holds within about 200 Hz from band to band. Resettability is perfect. No backlash or slack exists.

Drake T-4X

When I purchased the receiver I had no idea that I would ever get the matching transmitter. But after using the receiver for almost a year I was so impressed and pleased with it that I decided to get the T-4X. It has VOX, PTT, CW sidetone and operates at 200 watts on AM as well as SSB and CW. AGC is employed on SSB and eliminates overmodulation even though the gain might be turned to maximum. No TVI has been detected even to a portable TV sitting right next to the transmitter. It seems to pack quite a punch for 200 watts. I have received many 40 over S-9 reports and many people thought I must be using a linear. I am using a dipole mounted about 15 feet high.

The real beauty of the combination is its flexibility of frequency control. At the mere flip of one switch separate frequency control can be obtained or transceive operation can be selected with either the receiver or the transmitter controlling both units. One VFO can be left in the CW band and the other in the phone band and the proper VFO is selected instead of retuning across the band.

The extra VFO is very useful in finding a clear frequency while the other VFO is left set on the frequency of the person you are working at the moment.

Of course, if someone starts drifting you can switch to separate frequency control to stay with him with your receiver without altering the transmitted frequency.

A regular zero beat system is used for CW but for SSB a "canary" or warbling type of beat tone is heard. When the units are tuned to within 2 or 3 warbles per second, the separate units are tuned to within 2 or 3 Hz of the same frequency. This is much more accurate than the regular zero beat method normally used which might be in error by 100 Hz or more.

The new T-4XB and R-4B appear to use the same basic circuits with certain improvements such as: a 50 kHz calibrator for sub-band marking, and a newer and better crystal lattice filter in the transmitter for even better sideband suppression. They also have a new tuning knob and knob skirt or dial and a new chip resistant paint finish.

If you will compare I think you will agree that none of the competition can equal the Drake Line.

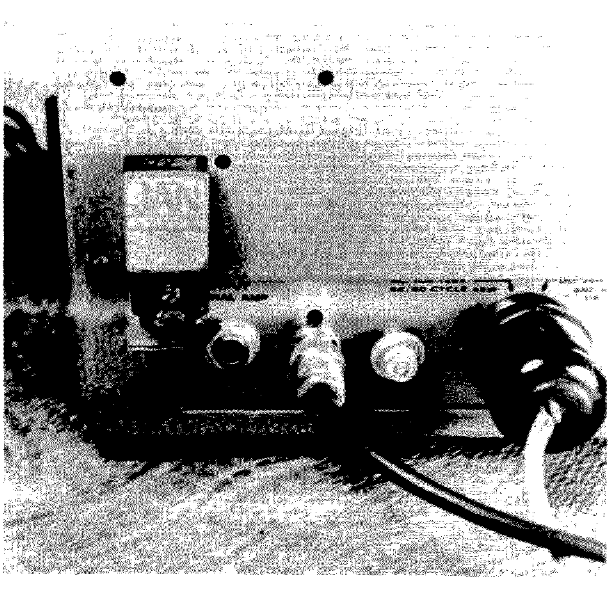
. . . WB4EFA

Operating Suggestions For The Two'er

E. H. Marriner W6BLZ
528 Colima Street
La Jolla, California

There have been numerous suggestions for improving the two meter Heathkit HW-30 transmitter-receiver also known as the Two'er. Here are some more suggestions.

In order to change crystal frequency it is necessary to remove the cabinet. The crystal originally is inside. A socket could be mounted on the front panel to remedy the situation, however, the long leads back to the original socket add so much capacity and inductance that the crystal may no longer oscillate. Some operators have solved the problem by cutting a square hole in the side of the cabinet. A better solution is to mount the crystal socket vertical at the back of the cabinet, and it does not take up much more space. A new .001 disk capacitor and a 22K 1 watt resistor will be needed because the new leads need to be slightly longer than the original components. To mount the crystal in the vertical position requires disk sanding a double type crystal socket down to the center hole. In other words do not cut the socket exactly in half. A number 41 drill hole is required through the side of the socket to fasten it to the back of the chassis. A dab of Armstrong cement will help the screw secure the socket in a solid position. Two tiny holes are now drilled through the chassis for the leads of the 22K and .001 mfd capacitor whose leads have been covered with Teflon type spaghetti insulation to prevent shorting of the leads to the chassis. To change crystals now only requires peering around the corner of the cabinet to pull the crystal out and to plug in another.



Mounting the crystal socket and the BNC coax socket.

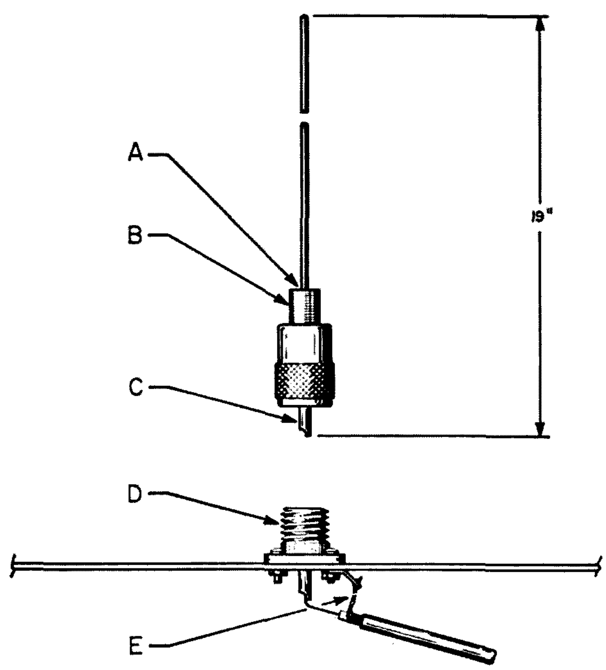


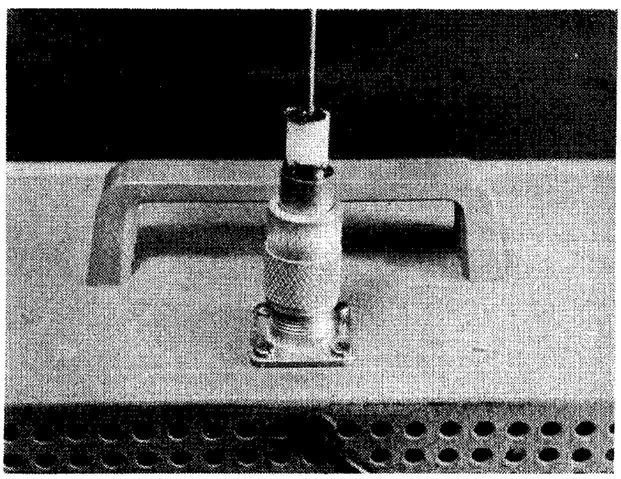
Fig. 1. Two meter antenna made from a type SO VHF coax plug.

A. use a number 41 drill through the nylon center to accept the rod. B. 3/8x1" nylon slipped over rod after soldering. C. Brass rod pushed in and soldered here. D. Plug installed on top of the Two'er cabinet. E. Coax braid soldered to lug.

Another improvement to the Two'er is to replace the phono type *rf* output socket with

Frequency	Crystal
144.000	8000 kc/s
144.18	8010 kc/s
144.45	8025 kc/s
144.7	8040 kc/s
144.9	8050 kc/s
145.31	8073 kc/s
145.35	8075 kc/s
145.440	8080 kc/s
145.500	8083.3 kc/s
145.620	8090 kc/s
145.800	8100 kc/s
145.900	8106 kc/s
146.000	8111 kc/s
146.090	8116.7 kc/s
146.200	8225 kc/s
146.500	8140 kc/s
146.700	8150 kc/s
146.820	8156.6 kc/s
147.1	8173 kc/s
147.2	8175 kc/s
147.6	8200 kc/s
148.00	8227 kc/s

a BNC chassis mount type. This will make it easier to change the RG58/U antenna cable. To put in this fitting the hole will have to be enlarged to ⅜ inches and the fitting will push in and the nut can be fastened to the underside of the chassis.



Mounting the portable antenna on the Two'er cabinet.

For portable operation in the backyard or on the dining room table, a vertical 19 inch whip antenna can be made and mounted on top of the cabinet. (see **Fig. 1**) It is only necessary to punch a ⅝ inch hole on the top of the cabinet and then solder on a short piece of RG58/U, and push it out one of the vent holes at the back of the cabinet. Now attach a BNC type fitting to the short lead and push it in the new BNC chassis fitting. The antennas can be made from a piece of brazing rod which is pushed through a piece of nylon insulation and is later pushed down into the SO type fitting and cemented after the rod has been soldered to the plug pin.

Each time a new antenna is used on the set the final will have to be adjusted for maximum output a fact often overlooked by operators because the ceramic output capacitor is inside the cabinet. A small hole can be drilled on the side of the cabinet so that a tuning wand* can be inserted to tune the final amplifier while watching the 0-1 mA output meter plugged into the back of the cabinet.

While these suggestions may seem trivial, they may be of great help to the person not familiar with the two'er, and they certainly make operating of the two-er much easier.

. . . W6BLZ

Technical Aid Group

Please refer any questions of a technical nature to one of the following members of 73's Technical Aid Group. These are dedicated amateurs who really want to be of help and do so without compensation. Be sure to state your problem clearly and enclose a S.A.S.E. for a reply.

John Allen, K1FWF, high school student, 51 Pine Plain Road, Wellesley, Mass. 02181. HF and VHF antennas, VHF transmitters and converters, AM, SSB, product data, and surplus.

Bert Littlehale, WA1FXS, 47 Cranston Drive, Groton, Conn. 06340. Novice transceivers, test equipment and homebrew projects gone wrong.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, New York 14619. Specializes in VHF/UHF solid-state power amplifiers, but will be glad to make comments on any subject.

G. H. Krauss, WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, New York 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitter and receivers, VHF antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Charles Marvin W8WEM, 3112 Lastmer Road, RFD #1, Rock Creek, Ohio 44084. Will help with any general amateur problems.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, New York 11360. Novice help.

Clyde Washburn K2SZC, 1170 Genesee Street, Building 3, Rochester, New York 14611, TV, AM, SSB, receivers, VHF converters semiconductors, test, general, product data.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, New York 11357. General.

J. J. Marold WB2TZK, OI Division, USS Mansfield DD278, FPO San Francisco, California 96601. General.

Ira Kavaler, WA2ZIR, BSEE, 671 East 78 Street, Brooklyn, New York 11236. SSB transmitting, color TV, computer programming and systems, digital, radio and remote control, rf transmission lines, dipole design, audio amplifiers, linear and class C rf amplifiers.

Fred Moore, W3WZU, broadcast engineer, 4357 Buckfield Terrace, Trevose, Pa. 19047. Novice transmitters and receivers, HF and VHF antennas, VHF converters, receivers, AM, SSB, semiconductors, mobile test equipment, general, product data, pulse techniques, radio astronomy, bio-medical electronics.

Walter Simciak, W4HXP, BSEE, 1307 Baltimore Drive, Orlando, Florida 32810. AM, SSB, Novice transmitters and receivers, VHF converters, receivers, semiconductors, mobile, test-equipment, general.

James Venable K4YZE MS, LLB, LLM, 119 Yancey Drive, Marietta, Georgia. AM, SSB, novice gear, VHF, semiconductors, and test equipment.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, Virginia 22042 General.

Wayne Malone W4SRR BSEE, 8624 Sylvan Drive, Melbourne, Florida 32901. General.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans, Louisiana 70118. Novice help and general questions.

Douglas Jensen, W5OG/K4DAD, BA/BS, 706 Hwy 3 South, League City, Texas 77573. Digital techniques, digital and linear IC's and their applications.

Louis Frenzel W5TOM, BAS, 4822 Woodmont, Houston, Texas 77045. Electronic keyers, digital electronics, IC's commercial equipment and modifications, novice problems, filters and selectivity, audio.

George Daughters WB6AIG, BS, MS, 1613 Notre Dame Drive, Mountain View, California. Semiconductors, VHF converters, test equipment, general.

Glen H. Chapin, W6GBL, 3701 Trieste Drive, Carlsbad, Calif. 92008. HF and VHF antennas, novice transmitters and receivers, VHF converters, semiconductors, receivers AM, SSB, general, surplus.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, California 91780. ATV, VHF converters, semiconductors, general questions.

Steve Diamond WB6UOV, college student, Post Office Box 1684, Oakland, California 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, VHF antennas and converters, receivers, semiconductors, and product data.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, California 95240. TV, HF antennas, SSB, VHF antennas and converters receivers, semiconductors, and general questions.

Hugh Wells, W6WTU, BA, MA 1411 18th Street, Manhattan Beach, Calif. 90266. AM FM receivers, mobile test equipment, surplus, amateur repeaters, general.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, Calif. 94952. Double sideband.

Howard Pyle W7OE, 3434—7th Avenue, S.E., Mercer Island, Washington 98040. Novice help.

PFC Grady Sexton Jr. RA11461755, WA1GTT/DL4, Hedmstedt Spt. Detachment, APO New York 09742. Help with current military gear, information from government Technical Manuals.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO New York 09665. Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

Eduardo Noguera M. HK1NL, EE. RE, Post Office Box Aereo 774, Barranquilla, Columbia, South America, Antennas, transmission lines, past experience in tropical radio communications and maintenance, HF antennas, AM, transmitters and receivers, VHF antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

D. E. Hausman, VE3BUE, 54 Walter Street, Kitchener, Ontario, Canada. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Frank M. Dick WA9JWL, 409 Chester St., Anderson, Indiana 46012. Will answer queries on RTTY, HF antennas, VHF antennas, VHF converters, semiconductors, mobile, general, and microwave.

Gary De Palma, WA2GCV/9, P.O. Box 1205, Evanston, Ill., 60204. Help with AM, Novice transmitters and receivers, VHF converters, semiconductors, test equipment, digital techniques and all general ham questions.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, Pennsylvania 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

William G. Welsh W6DDB, 2814 Empire Ave., Burbank, Calif. 91504. Club licensing classes and Novice problems.

Ralph J. Irace, Jr., WA1GEK, 4 Fox Ridge Lane, Avon, Conn. 06001. Help with Novice transmitters and receivers and novice theory.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 S.W. Salmon St., Portland. Oregon 92705. This group of radio amateurs will answer any technical questions in the field of electronics.

Ted Cohen W4UMF, BS, MS, PhD. 6631 Wakefield Drive, Apt. 708, Alexandria, Va. 22307. Amateur TV, both conventional and slow scan.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, Illinois 61820. Antennas, transistors, general.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, Illinois 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, Wisconsin 53402. Novice transmitters and receivers, general.

John Perhay WAØDGW/WAØRVE, RR #4 Owatonna, Minnesota 55060. AM, SSB, novice transmitters and receivers, HF receivers, VHF converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

Ronald King K8OEY, Box 227, APO New York, New York 09240. AM, SSB, novice transmitters and receivers, HF receivers, RTTY, TV, test equipment, general.

Charlie Marnin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, Ohio 44084. General technical questions.

Michael Winter DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, Ohio 45342. HF antennas, AM, SSB, novice gear, semiconductors.

David D. Felt, WAØEYE, television engineer, 4406 Center Street, Omaha, Nebraska 68105. Integrated circuits, transistors. SCR's, audio and rf amplifiers, test equipment, television, AM, SSB, digital techniques, product data, surplus, general.

Tom Goez KØGFM, Hq Co USAMAC, Avionics Division, APO New York, New York 09028. HF antennas, mobile, airborne communications equipment, particularly Collins and Bendix gear, AM, FM, or SSB—HF, VHF, UHF, general.

Robert Scott, 3147 East Road, Grand Junction, Colorado 81501. Basic electronics, measurements. ■

MOVING?

Every day we get a handful of wrappers back from the post office with either a change of address on them or a note that the subscriber has moved and left no address. The magazines are thrown out and just the wrapper returned. Please don't expect us to send you another copy if you forget to let us know about your new address. And remember that in this day of the extra rapid computer it takes six weeks to make an address change instead of the few days it used to when we worked slowly and by hand.

The S.O.B.

(Sightless Operators Bridge)

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218 Haloid
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If a sightless amateur could use a standard SWR bridge, he could make the proper adjustments to his antenna or matchbox to get maximum efficiency. But a blind operator cannot read a meter needle, so he is denied that valuable indication on any gear he may have. If the voltages are used to control an audio oscillator, they can be converted into a meaningful indication since most blind operators have very good hearing.

Here is a SWR bridge designed to indicate a null condition by the lowering in frequency of an audio tone. Only three diodes, three transistors, a UJT and a few other standard components are used. All semiconductors are silicon, for stability. Supply voltage is not critical, and the adjustments after assembly are few and easy.

Although I will describe this circuit as used in an SWR indicator, it could be used as a voltmeter with the addition of a fixed reference and appropriate multipliers.

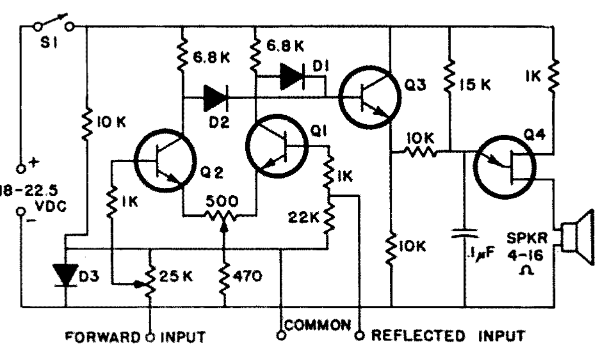

Fig. 1. Schematic diagram.

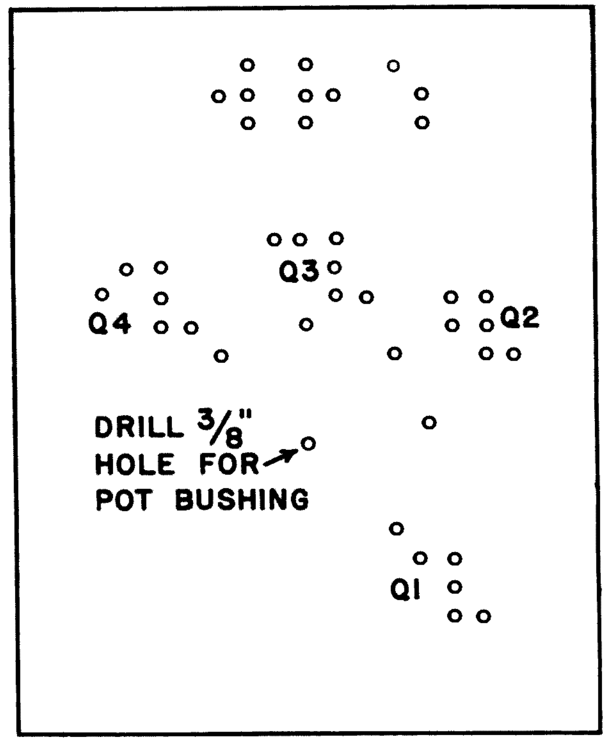

Fig. 2. Braille markings for front panel.

Refer to **Fig. 1**; you will see that transistors Q1 and Q2 make up a differential amplifier, which means both collectors will be at the same potential whenever the signal levels at the bases are equal. If they are not, then one collector will be higher than the other. The diodes D1 and D2 allow the base of the emitter follower Q3 to follow the higher collector. This puts the signal onto the 10 k resistor connected to the emitter of the UJT, and affects the time constant of the 15 k and the .1 µF capacitor. This varies the frequency of the UJT relaxation oscillator, which drives the speaker directly. The end result is that the audio frequency of the oscillator will rise if the signals at the inputs of the differential amplifier are not equal. Since the *reflected* voltage out of the SWR bridge is always lower than the *forward* voltage, we can find a position of the ratio pot where the amplifier is balanced. The position on the pot can be calibrated in Braille so the SWR can be read at the null position. Remember, the tone goes down at the null. Once the null is found, the tone will rise as the transmitter is peaked for maximum output.

With a good match (1.2:1 or so) a null can be detected with only three volts applied in against the reflected voltage, it would provide a sharper null with a poorer SWR. Naturally the null gets sharper with increased input. 20 vdc is about the maximum that should be applied to either input. If your SWR bridge puts out more than that, use a voltage divider to bring it down.

Note that the dc supply does not go to signal ground. This is so the signal can be

summed with the drop across D3 to prevent a 0.6 vdc dead zone. The signal voltages from the SWR bridge must be *positive* with respect to ground for this unit to work.

I said that the adjustments after assembly were few and easy. Well, one is few so here it is. Set the ratio pot to mid-range and apply a signal to top. About 6 vdc. Jumper the wiper of the ratio pot to the reflected input. This should force the bridge to balance. Measure between the collectors of Q1 and Q2. Adjust the 500 ohm pot until the meter reads zero. At this time, you should notice the audio tone dip in frequency as you reach the balanced condition. And that's all there is to it. One more check can be made at this time to insure proper operation. Short the base of Q3 to ground. This should cause the audio tone to drop to a low frequency. If it causes the tone to stop, change the 15 k resistor to a lower value.

To mark the dial in BRAILLE, use the pattern shown in **Fig. 2**. It is mirror image, so tape it to the inside of the chassis and punch through it. Use a small pointed punch and punch hard enough to raise the surface about 1/32 inch. Check to see that you can feel the pattern easily.

If possible, use a dual transistor for Q1 and Q2. It is nice but not absolutely necessary. Q4 is a 2N2160, but other UJT's will work as well. Almost any NPN Silicon transistor will work in this circuit, so don't be too fussy.

The UJT voltage controlled oscillator can also be used by itself in many applications to find a peak or dip in voltage. Some of the places that this could be applied are: Plate Current, Grid Drive, Output Power. Or the Face of the indicator could be marked to indicate Beam position if a pot were coupled to the rotor. I am sure that many more uses can be found, limited only by the ingenuity we can apply to the problems faced, which certainly isn't much of a limit.

. . . WA5SWD/6

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Getting Your Higher Class License

Part X – Basic Rules and Units

All electronics—not just amateur radio —depends upon a knowledge of a few basic rules and units. The units are voltage, current, resistance, capacitance, inductance, and reactance, and the rules let us determine how these units affect each other in any particular circuit.

Important though these units and rules are, it is possible to be a good radio operator with only a slight knowledge of them. Because of this, questions concerning these basics are at a minimum on the Advanced Class examination—and also because of this, we have saved our discussion of these until this last installment. Now it's time to take a look at them.

The questions from the FCC study list which require a knowledge of these basic principles to answer are:

15. A resistor, capacitor, and inductor each have 100 ohms of resistance or reactance. What is the equivalent series impedance of these three elements?
38. A transformer with 115 volts applied across the primary terminals has a primary-to-secondary turns ratio of 10 to 1. If a 5-ohm load is connected to the transformer secondary, the reflected primary impedance is what? How much voltage appears across one half of the turns of the primary?
42. How do inductors combine in series and in parallel? Capacitors in series and parallel?

Following our usual practice, let's paraphrase these detailed questions into similar ones of broader scope to cover the whole range of the subject.

All three of the FCC questions deal with effects that occur only in ac circuits. We're assuming that you have some working knowledge of Ohm's Law—but this law applies only to dc circuits. For a starting question to explore, then, let's ask "How does ac differ from dc?".

One of the major differences between ac circuits and dc circuits is that in ac, we must deal with "reactance" as well as "resistance." For our question, let's determine "What is reactance?". The answers we'll find there will lead directly to another question (which takes us back to the FCC study list), "What is impedance?"

When we have a relatively clear understanding of reactance and impedance, we can move on to a question dealing directly with all three of the FCC questions: "How do impedances combine?" Finally, we'll cover all the principles involved in FCC question 38, by asking "What does a transformer do?"

Most discussions of these subjects tend to lean quite heavily on mathematics; engineering texts in particular seem invariably to rely on calculus to deal with reactance. That isn't really necessary, and we'll try to prove it by using nothing more complex than ordinary arithmetic—except for the minute amount of algebra necessary to present the various rules for calculation of results. None of them are any more complicated than Ohm's Law: $E = IR$.

All set? Let's get on with it.

How does ac differ from dc? The terms ac and dc are simply shorthand, as you probably know, for "alternating current" and "direct current". The major difference between these two types of electric current are that dc flows directly through the circuit, always going in the same direction, while ac changes its direction at fixed intervals, alternating between "forward" and "reverse" flow.

A flow of dc in any circuit has three

major characteristics which we use to describe it: its voltage, or the "pressure" forcing the current through the circuit; its current, the "amount" of electrical energy forced through the curcuit in a specified period of time; and its polarity, which tells the direction of flow.

These same three characteristics may be used to describe ac, but all of them have to be varied a bit when it's ac we are discussing. The voltage in an ac circuit is always changing; at one instant it may be zero, a fraction of a second later it may be 50 volts, a little later 100 volts, etc. Similarily, the current is also changing at all times from zero to some peak value and back. Finally, the polarity reverses every half-cycle; this is the key difference between ac and dc.

If we put an oscilloscope onto an ac circuit we can see directly the variations in voltage. We can also see that in any one circuit the voltage will never be more than some "peak" value. If we're looking at normal power-line ac, the voltage will swing from a negative peak through zero to a positive peak and back to zero on every cycle, and the peak values will always be the same.

We *could* use this "peak" value as our measure of voltage, and in some types of circuits we do. We could also use the full voltage swing from negative peak to positive peak as our measure—and again, some circuits *are* rated in terms of "peak to peak" voltage.

However, the normal "voltage" we talk about in an ac circuit is neither the peak nor the peak-to-peak value. Instead, we use something called "RMS" voltage which works out to be about 0.7071 times the "peak" voltage or 0.3535 times the "peak-to-peak" value. The "RMS" stands for "root mean square" and refers to the mathematical method by which the value was originally determined. For our purposes it's enough to know the ratios between RMS, peak, and peak-to-peak voltages.

The reason RMS values are used is simple: if we use this ratio for our voltage and do the same for our current, the resulting resistance values make Ohm's Law work for ac as well as for dc. If we use peak voltages, the power figures are wrong.

Another way of putting this is that the RMS values represent the *effective* dc equivalents of the ac figures. If a dc voltage of 120 volts and a dc current of ½ amp are applied to a light bulb a certain amount of light and heat are generated. If an ac voltage of 120 RMS volts is applied to that same light bulb, an RMS current of ½ amp will flow and the same amount of heat and light will result.

This takes care of *two* of our three basic characteristics—voltage and current—but the third, polarity, is a little less simple.

In an ac circuit, by definition, the polarity or direction of current flow is always changing. It would seem that we couldn't use this as a means of describing ac since any ac always involves both possible polarities.

And while it's true that we can't use it directly, we *can* use it indirectly, by using the *speed* at which it's changing. This we call "frequency"; frequency is measured in cycles per second (now known as Hertz; 1 Hz equals 1 cycle per second). One cycle is one *complete* swing of the ac from any positive peak back through zero and negative until zero is reached the third time. It's just as accurate to say a cycle is the swing from positive peak through zero to negative peak through zero back to positive peak. The important thing is that a cycle is one complete swing of the ac from any specified starting point until that starting point is reached again.

The three characteristics of ac, then, are voltage, current, and frequency. Voltage and current can be measured in either RMS, peak, or peak-to-peak values, but only the RMS values correspond directly to dc volts or amperes.

It's quite possible to have two different ac signals which have identical values of voltage, current, and frequency, but which still are not anything like "correspoonding" signals.

This comes about because both the ac signals are always changing. If both of them pass through zero, positive peak, and negative peak at exactly the same instant of time, then the two signals *do* correspond to each other just as would two dc signals of identical voltage, current, and polarity.

If, however, one of the signals passes through its *negative* peak at the same instant that the other passes through its *positive* peak, then the two are mirror images of each other even though they do both pass through zero at the same time. If we were to try to mix these two in the same

circuit, we would find that one cancelled out the other and we would have nothing left.

This is the same thing that would happen if we tried to put together two dc signals of identical voltage and current but opposite polarity; again, the two would cancel.

You can see that, with the two ac signals we're looking at, the only difference is the time relationship between the two. This time relationship between two ac signals of identical frequency is known as "phase", and is always a relative measurement. It is just as accurate to say that signal A is "ahead" of signal B as it is to say that signal B is "ahead" of signal A; the only way in which we can talk about phase is to decide that *one* signal is going to be our fixed reference point, and then say whether the other is "ahead" or "behind" that rather arbitrary reference.

Another important fact concerning this idea of phase is that it applies *only* to signals of identical frequency. If the two signals we're talking about are of different frequency, then even if they start in the same phase so that both reach positive peak at the same time, they cannot both reach the following negative peak at the same time. If they *did*, they would be of the same frequency. Being of different frequency, they take different amounts of time to go through a cycle.

The key thing to keep in mind in any discussion of phase is that the word really is a measure of *time* even though we talk about phase in terms of "degrees".

The reason that phase is measured in "degrees" is that a full cycle of ac is like a circle. Every point around the circle is a different point, and similarly every instant within the cycle of ac is a different instant. Once we have gone all the way around the circle, though, we can't tell the difference between the second trip and the two-hundredth time around—and similarly once we have examined an ac signal all the way through a single cycle, we can't tell the difference between the second and the two-hundredth succeeding cycle.

Since one full cycle is similar to one full trip around the rim of a circle, we call a cycle 360 degrees. A half-cycle then becomes 180 degrees, a quarter-cycle is 90 degrees, and so on.

For any signal of specific frequency, though, these "degrees" are actually time measurements. For instance, if our signal's frequency is 1000 cycles per second, then one full cycle takes 1/1000 second or 1000 microseconds. This makes 360° of phase equal to 1000 microseconds. A phase "lag" of 180° then equals a time delay of 500 microseconds, and a time interval of 10 microseconds equals 3.6° of phase angle.

If we double the signal frequency, to 2000 cycles per second, all the time values are cut in half but the phase degrees are not changed. Now 180° equals 250 microseconds, and 10 microseconds equals 7.2.

To sum up all of this, the major difference in description between ac and dc are that dc is measured in constant volts, constant current, and constant polarity, while ac is measured in terms of varying voltage, varying current, changing polarity at a known frequency of change, and, if two or more signals of identical frequency are involved, relative phase.

When the idea of phase can be applied —which is only when frequency is not changing—it corresponds more directly to dc's "polarity" than does frequency. For example, two dc signals of equal voltage and current but opposite polarity will cancel each other out. So will two ac signals of equal voltage, current, and frequency, but 180° out of phase with each other.

What is reactance? Now that we have the necessary words and ideas, we can take a look at this thing known as "reactance" which is found only in ac operation; there is no dc equivalent.

So far we have talked about relative phase between two ac signals, with the unspoken assumption that we were talking about two distinct signals—maybe even on different wires—each of which had its own voltage and current values.

Actually, in the world of ac, voltage and current don't necessarily bear the fixed relationship to each other that they do when it's dc we're involved with. In a single ac circuit, with only one "signal" in the usual sense of the word, we have to think of the *voltage* as one signal and the *current* of that same circuit as another, separate signal.

When the "two" signals we're examining are actually the voltage and current in a single circuit, then they must be of the same frequency, and the idea of "phase" is applicable.

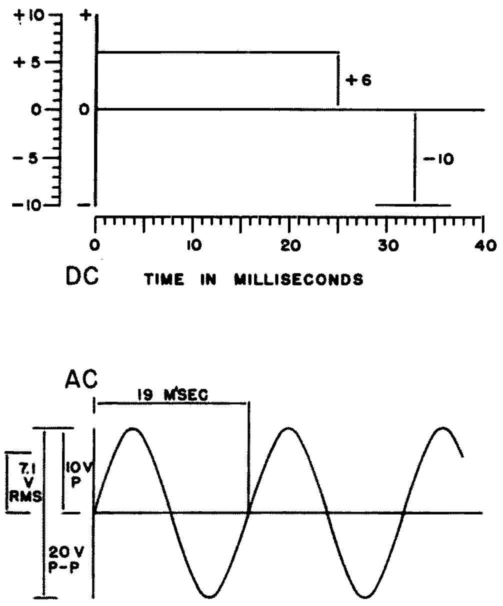

Fig. 1. Differences between dc and ac are shown by these illustrations which represent either current or voltage in a circuit. dc (A) is steady in the same direction, while ac (B) reverses direction at fixed frequency.

And like the two separate signals we examined a few paragraphs back, they can have any conceivable time relationship with each other.

For a start, let's assume that the two signals voltage and current are in perfect step with each other. The phase difference is 0°; when voltage is zero, so is current. When voltage is at positive peak, so is current. This is the "normal" case for an ac signal, and most descriptions of ac are based on this assumption.

However, it's possible for voltage and current to be out of phase. If they are out of phase with each other by 90 degrees, then when one is going through a peak value the other is zero. For example, if the current is 90° *ahead* of the voltage, then when voltage is at its positive peak value the current is zero. As voltage descends toward zero, the current value will be going towards its negative peak. When voltage reaches zero going negative, current is at the negative peak, and as voltage gets more negative the current is becoming less negative. When voltages reaches the negative peak, the current has again become zero going positive.

Now *power* in a dc circuit is simply the product of voltage times current, and in an ac circuit if both voltage and current are in phase is the product of RMS voltage times RMS current.

But when voltage and current are out of phase, the *power* available is *less* then the product of RMS voltage and RMS current. Staying with our current-ahead-by-90° example, when voltage is peak current is zero and power must also be zero. When current is peak; voltage is zero and power is still zero. During most of the cycle, current is peak; voltage is zero, and power is still zero. During most of the cycle, current is going one way and voltage is going the other, and again they tend to cancel out. The *only* time that any power is available in this situation is during that fraction of the cycle that voltage and current are both going the same way, and even then since both are far below their peak values the power is far less than would be expected.

If we shift things around so that voltage and current are a full 180° out of phase, then no power at all is available in the circuit although both voltage alone and current alone may be extremely large values.

This has the same effect as does *resistance* so far as available power in the circuit is concerned, but there's a major difference.

Resistance in a circuit converts the electrical energy into heat energy. Once that's done, the electrical energy is gone and we can't get it back.

The effect we're examining doesn't involve such a change. Instead, it merely changes the time relationship between voltage and current so that the energy is no longer available for use. If we should do something to change the time relationship back again, the energy would still be there for us to employ.

Because the effect is so similar to that of resistance, we measure it in the same electrical unit—ohms. Because it is *not* the same effect, we give it a different name, and this name is "reactance".

To put it simply, then, reactance, is just the measure of how much the time relationship between the voltage and current in a single ac circuit has been changed.

Since we can, if we use the *current* as the reference signal and consider the *voltage* as the signal which changes in time, move the voltage either ahead of or behind the current, the reactance can be either positive or negative. A negative reactance value means that the voltage has been delayed with respect to the current, so that the volt-

age is *behind* the current. A positive value of reactance means that the current has been delayed, so that the voltage is *ahead* of the current.

Two types of circuit elements have reactance, and the two have reactances of opposite types. The circuit elements are capacitors and inductors. The capacitor has negative reactance—which means merely that putting a capacitor in an ac circuit will cause the voltage to lag behind the current in that circuit. The inductor or coil has positive reactance; it causes the current to lag behind the voltage.

Frequently you'll meet the terms "capacitive reactance" and "inductive reactance." This just means that the net effect looks like either a capacitor or a coil, regardless of what is actually in the circuit.

Before we get away from this, let's take a small side trip and see why capacitors and coils have these effects.

First let's look at an empty or discharged capacitor and connect dc to it. At the instant of connection a large current will flow into the capacitor, charging it. As the capacitor charges it gains voltage of its own, and this voltage "bucks" the applied charging voltage. The current flow is determined by the effective charging voltage, and this effective voltage is equal to the actual voltage of the source minus the voltage on the capacitor.

The result is that as the capacitor changes, the charging current gets less and less. When the capacitor is fully charged, no current flows.

Now let's try that same thing with ac instead of dc for a source. Let's also assume that the ac is of fairly low frequency and the capacitor is of only moderate capacitance. Under these conditions the capacitor will have time to become fully charged before the ac reverses its polarity.

When the ac is applied, a large charge current starts to flow. As the capacitor's voltage bucks the applied voltage and current flow drops off, the applied ac voltage continues to change.

By the time the ac voltage reaches its peak value the capacitor has become fully charged and the current value is zero. So far the only difference between this and the action on dc is that with ac, the applied voltage was not steady but was always increasing.

When the ac voltage reaches its peak it begins to drop back toward zero. Now the

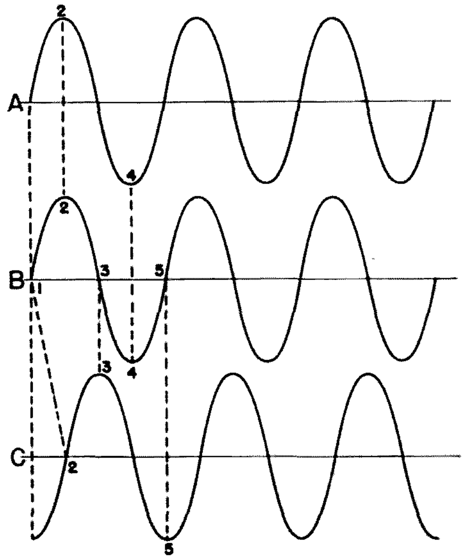

Fig. 2. "Phase" applies only to ac signals of identical frequency, and is a measure of their timing relative to one another. Here, for instance, signals A and B have 0° phase difference since they reach their peaks and cross zero at the same times. Signal C, however, is out of phase with either A or B since it peaks as they cross zero, and crosses zero when they peak.

capacitor is charged to a higher voltage than the applied voltage and it must begin discharging. It dumps out some charge, which becomes a current in the opposite direction.

As the ac voltage keeps dropping, the difference between the capacitor's voltage and the applied ac voltage gets larger and larger, so the current flow keeps getting larger and larger also in the reverse direction. When the ac applied voltage reaches zero, the discharge current is very high.

But as soon as the ac applied voltage goes through zero it changes direction, and now it's going the same way as the discharge current. This means that the applied voltage is now catching up with the discharge action and the voltage difference is getting smaller rather than larger. This in turn reduces the discharge current flow, so that the peak value of current occurs at the time voltage passes through zero.

As voltage moves toward the negative peak, the current flow continually decreases, and when voltage is at negative peak the capacitor's charge voltage and the applied voltage balance each other exactly. The resulting current flow is zero.

ac voltage then begins decreasing back toward zero, going now in the positive di-

rection. The capacitor is still charged to negative peak, so that the difference between applied voltage and charge voltage results in current flow into the capacitor in the positive direction again.

This process continues indefinitely; the current is always a quarter-cycle, or 90 degrees, ahead of the applied voltage. By definition, the reactance value when current leads voltage is negative.

If the capacitor is made larger, then it may not have enough time to become completely charged or discharged during any half-cycle of the ac signal. The current will still lead the voltage, but not necessariy by the full 90 degrees. If there is not enough time to fully charge the capacitor before the voltage polarity reverses, then the phase shift introduced by the capacitor will be less than 90 degrees. As we said earlier, reactance is a measure of how much the phase has been shifted—so that for signals of the same frequency a large capacitor has *less* reactance than a small one.

Since all this depends upon *time*, we can keep the capacitor size the same and change the signal's frequency to achieve the same result. If the frequency is increased then each cycle occupies less time, and again the reactance will be smaller.

Thus the reactance of any capacitor depends upon just two factors—the size of the capacitor and the frequency of the applied ac. If either of these factors goes up, the reactance goes down.

To calculate reactance for a capacitor, plug the two factors into the capacitive-reactance formula:

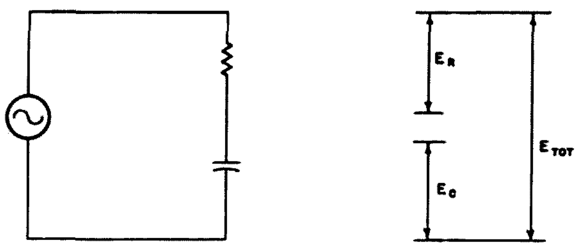

Fig. 3. This circuit illustrates differences between resistance and reactance in ac circuits. If resistance of resistor and reatance of capacitor are equal, voltages Er and Ec will be equal, but total supply voltage Etot will not be equal to the sum of the two. Instead, it will be less. See text and Fig. 4 for details of how this can be possible.

$$X_C = 1/6.28fC$$

In this formula, X_C stands for capacitive reactance, f is for frequency, and C is for capacitance. When the frequency is in cycles per second and the capacitance is in *farads*, the reactance comes out in ohms. However, farads are much too large a unit for practical capacitance values and we use microfarads instead. This changes the formula a little bit:

$$X_C = 159000/fC$$

The 159000 is a conversion constant which picks up the 6.28 of the earlier formula and also includes the million-to-one difference between farads and microfarads. In this formula, f is still in cycles per second but C is in microfarads. X_C is reactance in ohms.

When a coil is involved instead of a capacitor, the actions are similar but opposite.

When the applied ac voltage is zero nothing happens. As the voltage climbs toward its positive peak, current attempts to follow —but instead it is diverted by the coil into the *magnetic* field around the coil. So long as the voltage is climbing the current goes into the magnetic field instead of through the coil.

When the voltage stops climbing, at the positive peak, the magnetic field has its maximum energy. As the voltage starts to drop, it's not large enough to sustain the magnetic field at full energy and the stored current begins to be returned to the circuit. However, the voltage is dropping more rapidly than the energy can be released, and until the voltage drops to zero the current flow is continually increasing.

As the voltage passes through zero and starts going the opposite direction, a new current-storage effect begins to oppose the release of energy. The result is that current peaks at a voltage level of zero.

As the voltage moves from zero to its negative peak, the new current-storage effect and the previous current-release effect battle each other. The amount of current released continues getting smaller and smaller, and when the voltage reaches negative peak the two current effects finally cancel each other out to make net current flow zero.

Now as the voltage again climbs from its negative peak going positive, the effects re-

peat themselves with opposite polarity. The long-range effect is that the current lags behind the voltage—the opposite of the effect produced by a capacitor

As in a capacitor, the effect depends upon both the size of the coil (which determines the total amount of energy which it can store) and the frequency of the ac (which determines the time available for storage.) However, *inductive* reactance as in a coil goes up if either the coil size or the frequency goes up, while capacitive reactance went down.

To calculate inductive reactance, knowing the frequency of the ac signal and the inductance of the coil, use this formula:

$$Xl = 6.28fL$$

In this formula, f is in cycles per second (Hz) and L is in henries; Xl is in ohms. The formula is suitable in this form for power and audio frequencies. *rf* inductors are usually measured in microhenries; rather than changing the formula, simply use megacycles rather than cycles for frequency to use microhenries instead of henries for inductance, and Xl will still come out in ohms.

What is impedance? We have seen now how ac and dc differ, and we have defined "reactance" as a measure of the amount and direction by which the phase of the voltage in an ac circuit is shifted relative to the current in that same circuit.

Like resistances, reactances are measured in ohms, because like a resistance, a reactance reduces the amount of power available for use in the circuit. The major difference is that the resistance gets rid of the power completely by changing it to heat, while the reactance merely locks it up by changing time relationships.

Even though both are measured in ohms, reactance and resistance don't combine as directly as you might imagine. It's perfectly possible to have both in a circuit; in fact, it's impossible *not* to have both in any practical circuit. When both are present, the circuit behaves differently than it would with either alone. But it behaves in a manner which may at first appear a trifle strange.

Keep in mind that a resistance follows Ohm's Law for both dc and ac, provided only that ac voltage and current values are expressed in RMS terms. A reactance, on the other hand, appears on the surface to follow Ohm's Law—but its limitation of current (or voltage) is due to a time shift which it introduces.

Now take a look at the series circuit in **Fig. 3**, which contains both a resistor and a capacitor. We know that the capacitor has capacitive reactance; we'll assume that the frequency of the ac we're using and the size of the capacitor are such that this capacitive reactance is exactly equal to the resistance of the resistor.

Since both the resistor and capacitor are in series, all the current which goes through one must go through the other.

Going through the resistor, this current will produce a voltage drop determined by Ohm's Law, equal to the RMS current times the resistor value in ohms.

Going through the capacitor, this current determined by Ohm's Law—equal to the RMS current times the capacitive reactance in ohms.

This means that in this circuit, we have two separate voltage drops in series. It apparently stands to reason that each of them must account for half the total applied voltage; that is, if we put 115-VAC line power across the circuit we would expect to measure about 57.5 volts across each.

But that's not what happens. Instead, we'll measure about 81.6 volts across either the capacitor or the resistor.

So how can 81.6 volts in series with another 81.6 volts equal only 115 volts? The answer is, it all depends upon the timing.

These are ac voltages, remember, and an ac voltage is always changing from one peak value through zero to another peak. The only way 2+2 can equal 4 when it's ac voltages we're adding is if both voltages are "2" at the same time—and in this circuit, they're not.

Both voltages, you'll remember, resulted from current flow through the circuit. In the resistor, the voltage was exactly in phase with the current. However, in the capacitor, the voltage waveform lags 90° or one-quarter cycle *behind* the current.

That means that when Er, the voltage across the resistor, is at its positive peak, then Ex, the voltage across the capacitor, is only at zero, climbing toward positive. A quarter-cycle later, Er has reached zero on the downhill path and Ex has gotten to positive peak. The two are never in step with each other.

When both are going in the same direction, they add to and reinforce each other. When they're going in opposite directions, they tend to cancel out and only the larger survives in the total circuit. Fig. 4 shows this action by means of the waveforms of Er, Ex, and the resulting total-circuit voltage waveform.

The total voltage is the sum of the two individual voltages, and as you can see it is larger than either alone—but not twice as large.

In fact, with sine-wave voltages (which are the only kind we're talking about) the sum will be 1,414 times as large as either voltage alone, which makes the voltage across either element alone equal 0.707 times the total applied voltage, rather than half the total as we would expect.

We'll get back to this a little later, since it's the basis of one of the most important principles in radio. For now, let's continue down the road to find out "What is impedance?"

Take another look at **Fig. 4**, and this time notice the effect upon the timing of the various waveforms. The capacitive reactance shifted phase of the voltage a full 90° from that of the current while the resistor's phase shift was 0°. When the two voltages added together, the final phase shift was reduced to 45°.

When resistance and reactance are both present in a circuit, the phase shift is always less than 90°. Just how much less depends upon the ratio of resistance and reactance; in our example the two were equal so the phase shift was cut in half.

This combination of reactance and resistance in the same circuit is what's known as "impedance". Actually, "impedance" is the only thing you *can* have in an actual circuit. Pure resistance, like pure reactance, exists only in theory. Any resistor must have leads; the leads have at least a little inductance. This inductance puts a trace of inductive reactance into the circuit. Similarly, the insulation of a capacitor is never perfect; there's always at least some trace of leakage resistance through the insulation.

And even in theory, both pure resistance and pure reactance are merely special forms of the general idea "impedance". The best way to illustrate this is to look at the way engineers write down impedances.

Two ways are used; both have mathematic foundations but the math isn't important to us.

One way, based on the way a complex number is written, is to specify the impedance as the sum of pure resistance and pure reactance. If we represent the ohms of resistance by "A" and the ohms of reactance by "B", then the impedance becomes:

$$A + jB \text{ ohms.}$$

The "j" is from mathematics and indicates that the "B" is a reactance with 90° phase shift. The "jB" term may be either positive or negative depending upon the type of reactance involved.

The other way is to write the absolute impedance value and phase shift:

$$Z/\theta^{\circ} \text{ ohms.}$$

To use this way, "Z" must be calculated and so must θ; we'll stick with the "A + jB" method the rest of the way.

Now if we want to talk about a theoretically pure resistance, we can still describe it as an impedance of "A" ohms resistance and *zero* ohms of reactance, by writing "A + j0" as the impedance value.

Similarly, if we want to describe a pure reactance, it can be written "0 ±jB" ohms to indicate *zero* ohms of resistance but "B" ohms of reactance, with the + sign indicating that it's inductive or the − sign indicating capacitive.

Any time that neither A nor B is zero, you know that both resistance and reactance are present—and you're dealing with an impedance.

How do impedances combine? The reason we've gone into such detail about the "A" and "jB" method of describing impedances is that it makes all questions of combined impedances simple.

To calculate the impedance of a series circuit made up of several impedances (any of which may be "pure" resistances or reactances), all we have to do is total up the "A" values of each separately, do the same for the "jB" values, and write down the result.

Negative reactances cancel out corresponding amounts of positive reactance and vice versa.

For example, let's attack that study-list question about the 100-ohm resistor, capacitor, and inductor. First, let's describe the impedance of each of these elements sep-

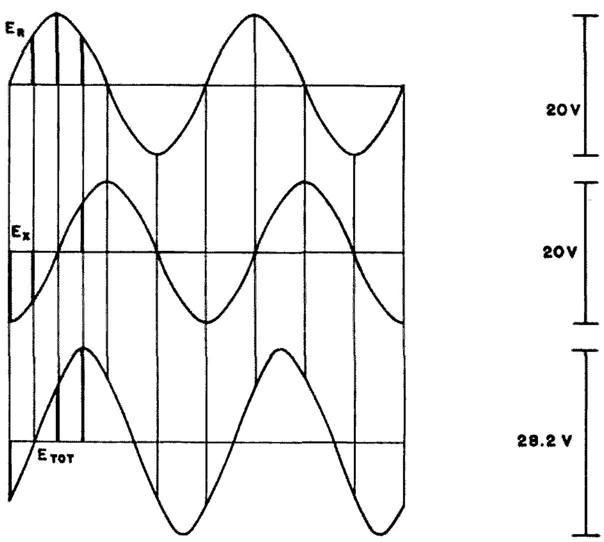

Fig. 4. Waveforms show timing differences between voltages across resistor and capacitor in circuit of Fig. 3. Total voltage always equals the sum of the instantaneous voltage values as indicated by the vertical matching lines. With 90° phase shift, peak of total is 1.41 times that of either part.

arately. The resistor would be 100 ± j0 ohms since it theoretically has no reactance. The capacitor would be 0 - j100 ohms since it's all reactance, and capacitive. And the inductor would be 0 − j100 ohms since it too is all reactance, but positive.

The total series impedance is then (100 + 0 +0) for the "A" side, plus (0 − 100 +100) or (0) for the "B" side, and we find quite directly that the effective circuit impedance is only 100 ohms resistive —or 100 ± j0 ohms.

So far as the effective impedance of the circuit is concerned, the capacitor and the inductor have cancelled each other out!

They're still there, though, and the current flowing through this series circuit must flow through each of the elements. The capacitor and the inductor won't have any effect upon the total current, so the only factor limiting current from the power source will be the 100-ohm resistance.

To keep the figures simple, lets assume that we have a 100-volt generator feeding a circuit like this. That makes the RMS current through the resistor 1 amp.

But that 1 ampere flows through the coil and the capacitor also, not through just the resistor, and it causes 100 volts to appear across the capacitor and another 100 volts across the inductor. These are voltages which can be measured with an ordinary VTVM.

What the meter won't show is that the voltage across the capacitor is 90° behind the current, and that across the inductor is 90° ahead. This totals up to a pair of voltages 180° out of phase with each other, and they cancel out so far as the external circuit is concerned.

With the values given in the FCC study question this may not seem like much—but let's try some different values and see how things shape up. Let's trim the resistance back to 1 ohm and leave the inductor and the capacitor at 100 ohms each. While we're at it, lets cut the voltage down to 100 volts RMS.

Our impedances now are 1 ± j0 ohms for the resistor, 0-j100 ohms for the capacitor, and 0±j100 ohms for the inductor. The total circuit impedance, then, is (1+0+0) ± j(0−100+100), or 1 ± j0 ohms. With 10 volts RMS applied, the current will be 10 amps RMS.

Note that the two reactances, being equal, have cancelled each other out just as before. But now we have 10 amps flowing through the circuit, so that the voltage developed across the capacitor will be 10 times 100 or 1000 volts RMS, 90° behind the current, and that across the inductor will also be 1000 volts RMS but 90° ahead of the current.

From the standpoint of the 10-volt power source, neither of these kilovolt levels exists. However, if we tap off just the voltage across either the coil or the capacitor—just the same way we would measure it with a meter—and feed it into an amplifier, we will actually get this 100-to-1 voltage step-up.

What's more, since reactance depends upon frequency, there's only one frequency at which any coil-capacitor pair has identical reactance. This frequency is known as the "resonant" frequency of the combination, and is the basis for all our tuned circuits.

We've already seen that any actual circuit must have both resistance and reactance; this means that we can never quite reach the ideal theoretical conditions we've been examining here. Reactive elements such as coils or capacitors, as well as combinations of these elements such as tuned cir-

cuits, are supposed to approach this ideal as closely as possible. They are rated by a "quality factor" usually known simply as "Q", which is the ratio of "energy stored" to "energy released" or more plainly, the ratio of *reactance* to *resistance* in the circuit.

For example, the FCC question uses values of 100 ohms for both resistance and reactance; the Q of this circuit is 100/100, or 1. Our modified version, though, had 100 ohms reactance and only one ohm resistance, for a ratio of 100/1 or a Q of 100.

The higher the Q of a reactive element, the more energy it will store. This is not always an advantage. Transmitter tank circuits, for example, must operate at relatively low Q in order to let the power be released to the antenna.

The same combination-of-impedances approach we have been examining throughout this section can be applied to the combining of similar impedances.

The key factor to remember is that impedances in series *add* their A and B values to each other, but impedances in parallel split the effects of their A and B values just as do resistors. The total resistance of R1, R2, and R3 in series is $(R1 + R2 + R3)$, but if the three are connected in parallel the effective value becomes $1/((1/R1) + (1/R2) + (1/R3))$

Similarly, three impedances $A1+jB1$, $A2+jB2$, and $A3+jB3$ in series have a total impedance of $(A1 + A2 + A3) + j(B1 + B2 + B3)$. In parallel, the picture becomes a bit more complicated since the value of $1/(A+jB)$ isn't so easy to figure directly. It comes out to be $(A-jB)/(A^2 + B^2)$, and when you start adding up a string of these, things get messy in a hurry.

It's actually easier to handle this kind of problem by ignoring "impedance" for a moment and going back to the values of inductance or capacitance involved.

When inductors are connected in series, their effects add up just as do those of resistors. In parallel, the effects are split just as are those of resistors. These statements are true *only* if the various inductors involved are not coupled to each other in any way; if they are, some transformer action gets into the picture and modifies the effects in an unpredictable manner.

Capacitors, on the other hand, behave oppositely—which we might expect since in all other respects they act as opposites to inductors. When capacitors are connected in parallel, their effects add up; in series, the effects are split.

To determine the impedance of a string of parallel-connected inductors or series-connected capacitors, then, you can simply figure up the effective inductance or capacitance by the parallel-resistor rule. Then plug this single value into the reactance formula to determine the effective reactance of the group.

What does a transformer do? The theory behind transformers usually is made to appear extremely complex, and it isn't helped a bit by the fact that we use these devices for both power transformation and signal transfer—with different theory for each application.

When we're talking about power transformers, we usually talk about voltage or current step-up or step-down, and sometimes about turns ratio.

When, on the other hand, we're talking about signal transformers, we almost invariably talk about "impedance matching".

Actually, the theoretical differences between a power transformer and a signal transformer are almost non-existent. What differences exist are detailed ones, concerning the frequency range, power loss in the wires, and the like.

The basic transformer itself could care less which job it's doing, because it does both in exactly the same way—by transforming *impedance*.

To see how this works, let's get used to thinking of power in "impedance" terms by looking at resistors instead. If you take a 120-ohm resistor and connect it to a 12-volt auto battery, it will permit the 12/120 ampere, or 1/10 amp, to flow. This 1/10 amp times 12 volts amounts to 1.2 watts. A 2-watt resistor could be used, but it would get rather warm.

If we use a 12-ohm resistor instead of 120 ohms, then 12/12 ampere—or 1 amp—of current will flow, and we will have 1 x 12 or 12 watts of power in the resistor. The point is that the voltage did not change—but by changing the resistance, we changed the amount of current taken from the battery and thus changed the amount of power we were using.

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changed the amount of current taken from the battery and thus changed the amount of power we were using.

Now a resistor is a special kind of impedance. Our first resistor had an impedance of 120 + j0 ohms, and the second had an impedance of 12+j0 ohms. Had we been using ac rather than dc the results would have been the same—reducing the impedance to 1/10 its original level while keeping voltage constant would have permitted 10 times the current to flow, or 10 times the power.

Had we left the resistor's value constant, but instead changed from a 12-volt battery to a 120-volt power supply to provide a 10-time increase in voltage, the power would have gone up by 100 even though impedance remained constant.

This happens because the current goes up right along with the voltage; while only 1/10 amp would flow at 12 volts for 1.2 watts, at 120 volts a full amp would flow. This is 10 times the voltage and another 10 times the current; the power increase is 10 x 10, or 100 times, for 120 watts.

Now a transformer consists, in its most basic form, of two coils which share the same magnetic core. When current flows through one of these two coils, it is accompanied by a magnetic field. The strength of the field depends both upon the strength of the current and upon the number of turns in the coil. This magnetic field (so long as it is changing) induces a corresponding current to flow in the second coil, and this induced current again depends upon the strength of the magnetic field and upon the number of turns in the coil.

Both coils, being coils, have inductance. Hence they have inductive reactance—and are both impedances, since the wire of which they are wound also has some resistance.

A well-designed transformer has little reactance or resistance of its own, but any *other* impedances in the circuit will reflect back to the transformer because they will affect current flow in the circuit. This will, in turn, affect current flow in one winding or the other of the transformer, and that it will influence the strength of the magnetic field which provides the transformer's main action.

One other factor, which we have already mentioned, also influences the transformer's action—the number of turns upon each coil. As it happens, the strength of the induced current (assuming that the strength of the magnetic field doesn't vary except as determined by the ac frequency) depends directly upon the number of turns in the coil. If a coil of 10 turns provides an induced current of 1 amp, then a 20-turn coil will provide twice as much or 2 amp. Similarly, the strength of the magnetic field depends directly upon the number of turns: if a 10-turn coil will induce a magnetic field of 1000 gauss (the unit of magnetic field strength), then a 20-turn coil carrying the same current will induce a 2000-gauss field.

The two windings in a transformer are called the "primary" and the "secondary". The primary is the winding carrying the original current which produces the magnetic field; the secondary is the winding in which the induced current produced by the field flows. Transformers may have many secondaries; most, though, have only one primary.

Since the number of turns on the primary determines the magnetic field strength with a given primary current, and the number on the secondary determines the induced current with a given magnetic field strength, the *ratio* "primary turns"/"secondary turns" gives us a direct indication of the current ratio to expect. The effects of the magnetic field, although indispensable to transformer operation, disappear from the scene so far as we are concerned.

Now let's back up a moment and look again at our resistor with varying voltages on it. When we boosted the voltage by 10 times, with fixed resistance, the current went up by 10 also.

Had we had any method of increasing current by 10 times, we would have found that the voltage went up accordingly. In either event, the power would have gone up by 100 times when either the voltage or the current was changed by a factor of 10, so long as the impedance (resistance) remained constant.

If we increased the current by 10 times but found it necessary to keep the *power* constant, the only way to do it would be to *decrease* the impedance by a factor of 100. Ten times the current, flowing through 1/100 the impedance, would result in 10/100 or 1/10 the voltage—and 1/10 the voltage

times 10 times the current would make the power come out at 1.

When we put a transformer with a 10-to-1 primary-to-secondary turns ratio into a circuit, the secondary current is 10 times as great as that in the primary as we saw before. But the transformer is *not* a power source; it cannot put any new power into the circuit. The total power, then, must remain constant. This means that the secondary voltage must be only 1/10 as great as that across the primary—and that the secondary impedance can be only 1/100 of that at the primary.

This is a general rule for all transformers; they transform *impedances*, and the impedance transformation is equal to the *square* of the turns ratio. When the impedance is changed, both voltage and current are also affected, and the transformation of *either* voltage or current is equal to the turns ratio alone (not squared).

A 10-to-1 transformer connected across a 115-volt AC power line, then, will produce an output voltage of 11.5 volts across its secondary. A 5-ohm load connected to the secondary will be reflected as 100 times 5 ohms, or 500 ohms, at the primary, and there it will draw 115/500 or 0.23 amps. The current set-up in this transformer is also 10 to 1, so 2.3 amps will flow in the secondary circuit. To check all this, 2.3 amps through 5 ohms should equal 11.5 volts—and it does.

If the primary is center-tapped, the turns ratio from half the primary to the secondary is only 5 to 1, so the impedance across either half of the primary is only 125 ohms rather than the 250-ohms you might expect. This is a fact about transformers which many persons find puzzling. So long as you think in terms of voltage and current, though, as we did in that previous paragraph, you'll come out okay. Across half the primary, we have half the 115-volt supply or 52.5 volts. We have, however, twice the normal primary current. This is because we have flowing in this winding the full primary current of 0.23 amps, and *also* an induced current of another 0.23 amps because of the current flow in the other half of the primary. With 0.46 amps and 52.5 volts, we find 52.5/0.46 or 125 ohms impedance.

Incidentally, realization of the fact that any transformer is an impedance-changing device makes it easy to find uses for iron in the junk box. Those surplus 400-cycle power transformers, for instance, come in very handy as modulation transformers. You can either calculate or measure the turns ratio by comparing primary and secondary voltages, and obtain the impedance transformation ratio by squaring the turns ratio. Many center-tapped high-voltage transformers work out nicely as push-pull audio transformers, for medium-power AM rigs.

In the case of a signal transformer, signals are applied to the primary. Their voltage and current are both changed by the turns ratio, and the transformed signals come out at the secondary to meet some "load" impedance. That load impedance, in turn, determines the actual amount of current which flows in the secondary circuit. No more current can be present than that determined by the load, and this is reflected back into the primary circuit. Thus our 10-to-1 transformer makes a 5-ohm load look like 500 ohms to the primary circuit. A transformer with a 30-to-1 turns ratio would make 5 ohms in its secondary look like 5 x 900 or 4500 ohms in the primary. Vacuum tubes require high-impedance loads, while most antenna or audio circuits operate at low impedance—so transformers are necessary in almost all stages.

Next Month. This winds up the Advanced-Class study course; about all that we haven't covered in it are the FCC regulations themselves, and there's no substitute there for reading the actual regulations. The key things to remember from them for the test are the frequency limits of the various bands, including the CW, phone, etc., sub-bands, the legal record requirements on logs, identification, and the like, and required operating procedures.

However, the response to this course has been so great that we're not stopping now. Quite a few of you, we suspect, will be interested in going beyond Advanced Class to the Extra Class ticket—so next month we'll dive into the Extra Class questions, with the same type of approach we've been using all year. Until then, good luck—and happy studying. ■

This completes the Advanced License course. The ten chapters in this course will soon be available in book form. ed.

Care and Feeding of a Ham Club

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Part VII — Operation Public Service

Unlike basket weaving and chess, amateur radio is a hobby that not only entertains and educates but comes through during disasters to provide emergency communication. When ice storms, fires, floods, tornadoes, and hurricanes strike, radio clubs are called on to go to bat, and members should know how to use their stations at such times. And there definitely is "know-how" involved. It's o.k. to give handle and QTH and drag out a signal report during a leisurely rag-chew, but when power lines are down and messages pile up, snappy, down-to-business procedures should be used to get the most said in the shortest time.

Although most hams realize the need to be prepared for emergency conditions, there may be a spat at a club meeting about how much time should be devoted to planning and drilling. If the members vote unanimously to participate in the AREC/RACES program (Amateur Radio Emergency Corps and Radio Amateur Civil Emergency Service), drills can be planned frequently. But should some members feel the club is meant to be "all-fun and no-work," then training will have to be sandwiched in with other activities or perhaps scheduled for a different evening.

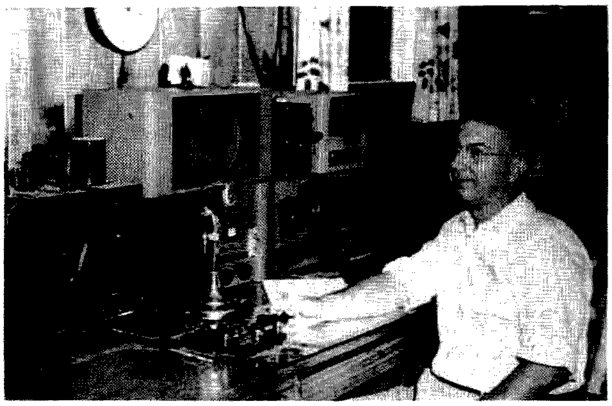
Many clubs have worked hard to convert buses and panel trucks into complete stations with transmitters on all bands, several operating positions, and even coffee bars. Any member of the Western Illinois Radio Club at Quincy will vouch for the value of a well-equipped bus after the April '60 flooding of the Mississippi.

Faced with a shortage of men to sandbag, the hams patrolled the levees with hand-carried transceivers and called workers to weak spots. The entire operation was coordinated by the local hams working through the privately-owned and equipped emergency bus operated by Ken Morrisson, WØTBI, of Hannibal, Missouri, just across the river. Your club may not be able to buy a bus, but purchasing a generator for emergency power should definitely be a goal.

The American Radio Relay League will gladly send a raft of material on AREC organization upon request. *QST* features a monthly column on AREC/RACES activities where you'll find spine-tingling adventures that really happen—stories of hams who have used their stations to evacuate flood victims, order medical supplies from around the world, find lost children, dispatch trains, and answer every imaginable call for help.

From time to time, newspaper headlines announce the name of an amateur or a club who have literally saved lives by knowing

A fully-equipped emergency truck or bus manned by local hams is an asset to any community and may be called on for communication and rescue missions. Shown above is the Ottawa, Illinois, team displaying their generator.



Francis Wentura, W9AEX, of Quincy, recalls the 1960 Mississippi floods when area hams literally saved the day with patrols along the levees.

what to do in a pinch. You and your club should make it a point to be ready, too.

Clubs on campus

Almost every college has a fine station and a lot of hams on campus, but club officers have to use dynamite to move anyone to a meeting. In the first place, students have little time for leisure activities, and, after all, they're usually in college, for schoolin' not foolin'. Nevertheless, a meeting a month and a ragchew now and then can provide a welcome change of pace for the busiest YL or OM.

As a hint for campus officers, get-togethers should be scheduled when the most folks can attend whether it's 10 A.M. Tuesday morning or 3 P.M. Saturday afternoon. At least one kind of "bait" is a club station licensed members can use for phone patches home and an occasional ragchew just to let off steam. If the equipment is ready to go at all times instead of being dismantled and strewn around the shack, all kinds of fun can be stirred up. Competing with other college clubs on Sweepstakes weekends and for DX contests and Field Days will probably bring in every ham enrolled.

A fixed base station can also spark a campus net or ragchewer's club creating between-meeting interest. Some of the most active young hams ever licensed lose their enthusiasm in radio during college years just because they're completely off the air. Campus radio clubs fight back by seeing to it that members operate at least once in a while. Unless the Dean has a rule on it, transceivers using short whip antennas can be plugged

into a dormitory outlet and fired up for local ragchews or merely "reading the mail."

A campus club takes the spirit of amateur radio plus hard work." Like a lot of other groups, most members are strangers in town, so strive to have a Club-away-from-home-Club.

Officers mustn't be afraid to try something new, and on the spur of the moment. A weekend field trip with portable gear or a CD drill with mobiles patrolling the campus doesn't have to be planned for months in advance. Impromptu parties and activities dreamed up when the work load lightens a bit will strengthen your club and probably call for a repeat later on. The Johns-Hopkins ARC holds an annual beach party they laughingly call an "orgy," and spring picnics are popular, too. A chance to get off-campus for a pre-June Field Day will be a big hit; in fact, just about any chance to get off-campus.

At a small school, the scarcity of hams may be a real snag. But there's an answer to this one, too. Unless you have time to recruit and train novices, take a look around and invite the non-college amateurs who live in the surrounding area. A ham is a ham no matter where he is, and most fellows and gals jump at the chance to visit a new club and become a member. Besides that, opening the campus club to locals can be the beginning of some fine new friendships.

Although we've been talking mostly about co-educational and men's colleges, let's not forget the girls. If you happen to be a licensed YL at Vassar, there's only one way to get gals to take up hamming—QSY your club to where the boys are!

73

Feedback can be either negative or positive, and so can your radio club. So far we've concentrated on ideas and plans your club *should* try, but, needless to say, there are *tabus* to avoid, too. Officers and members alike should work against *cliques* forming within the club; that is, the old time operators sticking together, the novices forming another group, and the technicians staying to themselves. Before long, the groups will start picking at one another and a first-class feud will break out and ruin the club's spirit. Novices can learn from the veterans, and technicians can often bring the 20 year men up to date on new developments. And, although the girls may not appreciate this comment, they should leave the "Have you heard about Helen" remarks at home for the good of the club.

Trying to force some idea on the members that they don't want is asking for trouble. All activities must be something the hams are interested in. A club should be organized around the hams' abilities, and all officers might make a mental note of this opinion. A club can be successful if the officers find out what the members want to do and follow it through regardless of how off-beat it may seem at first.

If your group doesn't seem to favor any particular activity, you can use a free hand in planning. The club which stands still soon disintegrates. Plan plenty of social events, nets, and projects. Take a tip and look over your own club's doings for the last year or so. Has everything been too much on-schedule with picnics held the same month and parties planned at the same place? If so, get out of the rut right now. Better to run the chance of a flop than let the club go stale. Stamp out boredom before it starts.

At the risk of resembling a "do-gooder," club officers should learn a code which isn't made up of dits and dahs. "The Amateur's Code" is a short bit of writing that reminds each ham to be gentlemanly, loyal, progressive, friendly, balanced, and patriotic, too. Anyone who lives up to these goals will be a credit to his hobby, to himself, and most certainly to a radio club.

The answers to such irritating questions as "Can't we do something interesting at our meetings?" and "Why don't we have as much fun as the Up-Hills Club?" may not be found in the Code, but it will sure help you hold your temper while you find it!

And now, although it's a lot easier said than done, Good Clubbing to you and 73!

. . . W5NQQ

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters have been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

European VHF

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Except for moonbounce and satelite communications, one rarely hears or reads of the VHF activity on the European continent. I can recall only one or two not-so-recent articles in all of the three major amateur publications. How many even realize that there is really quite a bit of VHF activity—especially on two meters—in all of the eastern and western countries of Europe?

Before I was assigned to Berlin, I held the general misconception that European VHF-ers were few and far between, if they existed at all. I assumed that the two meter band would be as dead as it is in Idaho, where VHF stands for "very high frustrations". I had brought along an SB-34, thinking I'd work lots of DX and keep in touch with stateside. Instead, I spent a whole year with low power trying to squeeze a signal onto the overcrowded HF bands. Erecting a quad only seemed to increase the QRM. During a feeble moment I paid money for a linear and tried to smash holes in the band, but I never did find the Empty Frequency, so all I did was rum up the electric bill.

Last summer, during one of the giant weekend contests while trying to get a QSO in edgewise and lengthwise to no avail, I decided to throw in the towel and do something else. Out of desperation I even called a local friend on the landline. Unfortunately, it seems that in Berlin the telephones are so heavily bugged by Us and Them and practically everybody else, that signals are about 30 down in the mud and I could only give him about an S-3 report.

I finally sold out. About two or three months later a friend loaned me an ancient S-38 with a one nuvistor two meter converter. I was surprised at all the activity I found. Besides abundant local signals, on good nights using just a modified three element TV antenna, I logged several nearby countries: SM, OK, SP, and others. Most of the DX was heard on CW, with occasional SSB, and everything else as AM. FM is as rare as a 19¢ hamburger stand over there. Contests are frequent and are quite low key, and are therefore a lot of fun, even for a non-contester like me. There are club bulletins, code practice sessions, and ragchews as long as one wishes. After hearing all this, I was sold. A bit of timely operating with a modest set-up could net about 25 countries, and a lot of local friends during my stay overseas. It got me dreaming of what I could do with a Gonset GSB 2 SSB transceiver and a good 16 element collinear array.

Well, I got the Sidewinder, but it put me so far in the hole money-wise that I've had to settle for a five element bamboo and bent coat-hanger antenna (the BH-2, July '64 in 73). Now we hang our clothes on the floor until I can scare up some more hangers (wooden types this time, insists the XYL).

Since I'm now quite penniless, I begged the wonderful and most understanding wife for two bucks and purchased a keen 20 foot bamboo pole I had spotted at a local grass and flower factory. I then pounded a four inch diameter, five foot long water pipe into the ground and slipped the bamboo pole into the pipe—presto—a hand rotable 20 foot tower. Not really very high, but I wouldn't want to fall that far.

Having worked through my days off pummeling my "sky garage" into some kind of working order and locating it in the stratosphere, I had the thrill of my first VHF contact in Europe from Berlin—to Berlin. Alex, DC7AS, was kind enough to provide me with a critical signal report and even sent a taped recording of our QSO. I should receive more QSL's like that!

Language would be a big problem if it weren't for the fact that nearly all the amateurs of the western European countries use English as their second language. Most have taken it as required curriculum in grade and high schools, and I've found that most of the eastern European hams speak enough English to get by. In any case, it doesn't take very long to pick up enough of the local language (German, in my case) to use for short QSO's. Since I'm the only American ham in Berlin, almost everything I hear on the air is in German. It's no problem though, for as soon as I make a con-

tact the language switches to English. It won't be too long before I become proficient enough in German anyway.

The intention of this article is to help persuade some of the VHF-ers in the States who are coming to Europe, whether for vacation or by military assignment, to bring their equipment along—even just a Two-er—and apply for a license. Most European countries have signed a reciprocal licensing agreement, but it's best to check far in advance to see if it's really happening in the country or countries you wish to visit. VHF mobile is a bonus in Europe—signals are horizontally polarized, so bring a halo. For fixed stations, a four element beam is about the smallest practical antenna. With that, one should be able to work at least a dozen countries from anywhere in Europe. If you are able to work 10 states from your stateside station, you should be able to work at least that many countries over here. Where I am, in Berlin, there are more than 20 countries within range of 20 watts of SSB into a good beam. With aurora and meteors activity during the Fall, the band goes pretty wild!

Don't forget that the European two meter band is only two megs (144 to 146 MHz) wide. If you go rockbound, three crystals will do: 144.01 for CW; 144.5 for AM; and 135.425± 25 kHz for SSB. The last frequency is almost always monitored for any type signal, and is also one of the main DX frequencies.

I'll be here for quite a while to come, so if you ever visit Berlin, be sure to look me up. I've got cold tea, hot coffee, fine German beer, and I'd be glad to loan you my five element coat-hanger. I sure would like to hear some more Americans on two meters in Europe!

. . . DL5QN

Rambling On —

Jim Ashe W1EZT

If you have constructed a circuit and it doesn't work, maybe there was a mistake in the article. That does happen, and a good exercise before starting anything described in *any* magazine is to read slowly through the schematic looking for a mistake. Here are some examples of mistakes appearing in 73 Magazine.

Vackar VFO

In our October issue, "New Life for an Old Circuit" needs another look. See page 41. Blocking capacitor C9, between R7 and L4, was omitted from the schematic. A value of .01 mfd. will do nicely, but if you are using junk-box parts of uncertain value watch out for a capacitance that resonates with L4 at the operating frequency. A series-resonant circuit here could reflect a heavy load back through Q2 to the collector of Q1, with a possible reduction of stability.

This article also got off without a list of references for further reading. Try these suggestions for more information:

A Stable VFO for VHF or HF, by Del Crowell, 73, Nov. 1966.

The Vackar VFO, A Design and Try, by Gary B. Jordan, Electronic Engineer, Feb. 1968.

New Circuits Concepts for CB Transmitters, Motorola Application Report #84.

RCA Applications Guide ICE-228.

Credit for the original Vackar VFO design used in this article should have gone to Gary B. Jordon.

6 Meter Transmitter

Ken Robbins' article in the Sept. issue could use a bit of touching up. That is the 6-Meter Exciter schematic on page 53. Looking at the 2N3662 crystal oscillator, the 100K resistor extending downward from the transistor base terminal ought to be labeled 10K. The circuit may oscillate at 100K, but with small power output.

And looking at the two MPF105's which serve as a variable frequency oscillator and source follower, we note these are fed through a 330 ohm resistor. The circuit will work as shown, but with degraded stability.

Ken says this point (the junction of the two drain terminals and the 330 ohm resistor) should be held at a fixed voltage with an 8 volt 0.4 watt zener. The zener is bypassed with a 1 mfd. 10 volt capacitor to kill possible zener noise. Careful about polarity—the zener's diode arrow will point at the circuit, rather than at ground.

6 Meter Transceiver

Our September issue contains a nice article on building a solid-state Six Meter Transceiver. But the article was not as nice as it might have been, since it was short the following data on winding up the coils:

L1: 5 turns #26, ¼" long x ⅜" dia; 2 turn link on cold end.

L2: 5 turns #26, ¼" long x ⅜" dia; tap 2 turns from cold end, 2 turn link on cold end.

L3: 6 turns #18, 1" long x ½" dia; tap 1¼ turns from cold end, 2 turn link on cold end.

L4: 10 turns #26, ½" long x ¼" dia; tap 3 turns from cold end, 3 turn link on cold end.

L5: 75 turns #26, 2 layers, ⅜" dia; 3 turn link over middle of outer layer.

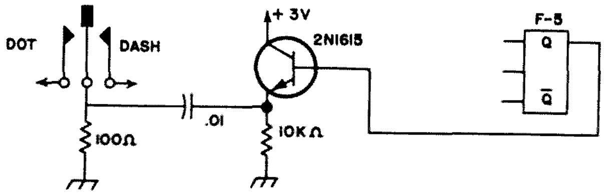
L6: 7 turns #26, ½" long x ¼" dia; tap 3 turns from cold end.

The Micro-Ultimatic

Sometimes we get letters on material printed some time ago, and here is an interesting one. It comes from Glen Winkler, WAØIFV. Glen writes,

"I just finished construction of "The Micro-Ultimatic" (June 1966 p. 6) and am delighted with the results. I etched two double-sided boards and soldered the IC's directly to the boards. Each board is 3½ x 2½ inches and easily holds all components. I have one correction and one suggestion to make. Fig. 7, page 13, should show a connection to "A" instead of "B." I could not achieve the dah-dit-dah-dit-etc pattern with both the dot and dash switches closed. The dot memory, dash memory etc., appeared to operate properly but a series of dashes occured when both the dot and dash switches were closed. The following modification corrected

this difficulty and essentially inhibits the input gates during shift register operation."



Now, do these mistakes have anything in common? Yes, there is an instructive similarity: they aren't subtle mistakes. A missing table, a wrong resistor value, a missing zener diode. Each of these is something visible to a skeptical eye. And a good scrutiny of an unfamiliar circuit is an excellent way to find weak spots in your theory background. Like calisthenics, the exercise tells you where extra work is needed.

Just enough room here for a couple hints to writers. Simple hints. How do you know if *73* would be interested in some idea you are thinking about? Simple. Read the last three issues very closely. There you can see what the editors have been thinking about, and against this perspective you can judge if your own idea might go over, or not. Remember that a part of the life of any magazine is change as well as continuation of present policy, so don't be afraid of new ideas. That's no promise, though. To paraphrase the old woodsman, if you've never had an article bounce you haven't written anything.

. . . W1EZT

(*W2NSD/1 from pg.* 4)

How about a channel where they can find compatriots?

Car buffs get a great kick out of discussing the new models, the merits of various sports cars, rallying, engines, and even the Mercedes 190D. Couldn't we set up a channel where these blighted creatures could congregate and lament over the sad developments in Detroit?

Our bands are already overcrowded, so where could we possibly put a bunch of new nets? It might be worth while to try 20M since most of the contacts there are two-way at present and the establishment of roundtables would permit many times the occupancy of the frequencies if the stations were netted.

As a starter let's try the following channelation of our interests. Undoubtedly I have neglected to think of a large number of widespread groupings, but let's get started anyway with this and work it from there.

14250	DXing
252	Religious
254	Girls
256	Traveling
258	Hunting-Fishing-Diving
260	Stamps-coins
262	Photography
264	Astronomy
266	Animals
268	Boats
270	Spectator sports
272	Cars
274	Golf-skiing-skating
276	Occult
278	Doctors-lawyers
280	Flying
282	Books
284	Clubs: Masons-Rotary-etc.
286	Boy Scouts
288	Languages
290	Stock Market
292	VFH-moonbounce-scatter
294	CD, RACES, etc.
296	Ham TV, RTTY, FAX, FM
298	Arts: music, painting
14300	UFO Net

The DX'ers should, I suspect, be first. It might just be helpful for DXing to have a channel to check for latest news and QTH's. It is a lot more fun to hook something rare if you have an opportunity to tell the other fellows about it and offer, solicitously, to help them get through as you did.

We have around the world quite a number of missionaries and padres who are active on our bands. I know that they particularly enjoy being able to contact each other and a channel on 252 should help them out. Of course the DXers in the next channel will keep their ear peeled for some of the rarer ones such as 9N1MM and 9X5GG.

Frankly I am not at all sure what can be discussed as far as girls are concerned, but I do know that they are of great interest to many amateurs and every time I have proposed this channel idea to a radio club there has been a demand for a girl channel. So be it.

If you have any interest of your own that doesn't seem to fit the list and which you feel should be represented, drop a line and we'll try and set up a special time or day for it on one of the channels that seems to have less activity than the others.

Let's give this a try and see if it develops into anything of value. Dissidents can get together on 14302 and coordinate.

. . . Wayne

Letters

Dear 73,

Kagnew Station Amateur Radio Club (ET3USA) is a small club—mostly military personnel—with a very limited treasury. At present we can barely afford the cost of printing QSLs and mailing logs to our QSL manager, plus the other costs necessary to keep the club going.

We regret we must ask for S.A.S.E. or IRC from all hams desiring QSLs. Please do not QSL direct to us. VE3TG has all logs and QSL cards.

We are trying to keep the station on the air as much as possible despite difficulties. All equipment here is owned by individuals and it looks as if we'll lose the beam we're using when the owner returns to the States in December.

ET3USA—Mrs. Deane Lindsay
W4EJQ—Secretary

Dear Wayne,

I just received my November issue of 73. I'd like to offer my compliments to you and your staff for an excellent cover. I don't know who your art makeup person is, but you're not paying him (or her) enough. The October cover was also just great. Please accept my congratulations.

I read your column "de W2NSD/1." You ask that anyone hearing "self righteous policement" to tell them that "Wayne Green says that he is sick and needs immediate mental treatment . . . "

I am so sorry to hear that you are suffering from some kind of mental illness problem. Would you please accept the enclosed dollar? I sincerely hope it will help toward your rapid recovery, because I hate to see anyone suffer.

A. Wilson W6NIF
San Diego, Calif.

Thanks a meg for the dollar. I took it right down to the local psychiatrist and invested in two minutes of intensive first class therapy. You will be happy to know that I have been pronounced completely cured and that all the thanks goes to you. Wayne.

Dear Madame,

Following the publication of my article "Burn Prevention" in the July issue of 73, I had several inquiries about the German soldering pistol pictured therein. The pistol, called the Sprint, is made by Europe's foremost manufacturer of soldering equipment, ERSA Ernst Sachs K.G., 6980 Wertheim am Main, Postfach 66, West Germany. The unit, because it does not use a conventional transformer as in other fast-heating irons, weighs less than half a pound and still heats up to about 100 watts in 10 seconds. Cost is about $8 plus postage.

D. E. Hausman VE3BUE
Ontario, Canada

Dear 73,

Your very good Advanced Class study guide articles are wonderful. Well written in common sense terms. The writer is easy to understand. I've read a lot of radio articles, but these are just great. Thanks much.

E. Schaldack WA9QQV
Chicago, Ill.

To the 73 Gang,

Just so my conscience is free and I get a good night's sleep, I felt obligated to write you regarding the fine magazine. Some time ago, I thought I'd drop the thing. Then you started the Advance Class License Course, which is, by itself, worth the price of the magazine. I like the "Editorial Liberties" by Kayla . . . if there is something outstanding about the publication, it is the "personal" feeling as though you were among friends. Best wishes for continued success.

C. E. Shaffer WA9VRK
Plymouth, Indiana

These are just two of the hundreds of letters which have come from readers in response to the study course. The Advanced course will be completed with this issue. We will immediately have it put in book form. Beginning with the February issue, we begin the Extra preparation.

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HAM AUCTION, Feb. 16, 14th Annual by Toledo Mobile Radio Ass'n, at the Lucas County Recreation Center, 2901 Key St., Maumee, Ohio. $1.00 Registration, open table sales, map and further info. write Ron W8STA, 1939 Cone, Toledo, Ohio 43606.

WANTED: Opportunity to quote your needs. 30 years a ham dealer. Collins, Drake, Swan, all others. $20,000.00 inventory used gear. Electronic Distributors, 1960 Peck, Muskegon, Michigan 49441.

TEST EQUIPMENT WANTED: Any equipment made by Hewlett-Packard, Tektronix, General Radio, Stoddart, Measurements, Boonton. Also military types with URM-( ), TS-( ), SG-( ) and similar nomenclatures. Waveguide and coaxial components also needed. Please send accurate description of what you have to sell and its condition to Tucker Electronics Company, Box 1050, Garland, TX. 75040.

ESTATE LIQUIDATION SALE: Johnson Invader with Johnson low loss filter, $75.00; Heath HW-30 with microphone and instruction, $30.00; Heath IM-11 VTVM, $30.00; Heath IT-12 signal tracer, $15.00; RCA Voltohmyst Model WA65A (battery), $25.00; Waters Protax model 335 coax switch, $8.00; Barker-Williamson model 350 coax switch, $5.00; Signal Corps Bug key type J-36, $8.00; (4) new Eimax 7203/4CX250B tubes, $20.00 each; Ameco VHF model CN converter with model PS-1 power supply, $25.00. Arthur W. Lee, Rte #1, Box 23A, North Monmouth, Maine 04265. Tel: 207-933-2869.

SELL: SX-130 still in original box, won at a hamfest. Best offer over $125.00. Tom Hentz, WA9MCB, Room 326, Thomas Jefferson Hall, Rolla, Mo. 65401.

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WANTED: Back issues of 73 Magazine, November 1960 through March 1961. C. W. Janes K2KS, 2 Windsor Gate, Upper Saddle River, N.J.

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WANTED: Military, commercial, surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Rico Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

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WANTED: Teletype equipment & parts. Also R-390A, U-R, R-220, etc. Cash or trade for new amateur equipment. All-tronics-Howard Co., Box 19, Boston, Mass, 02101. (Tel. 617-742-0048).

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WANTED: Plug-in preamp for Hewlett Packard 150A scope. Also Fairchild 781 frequency standard. Sell: AN/APR-4Y receiver AC converter $30. Howell, 2492 Habersham, Atlanta, Georgia 30303.

SELL: SB400, excellent condition, $275 or make offer, S.A.S.E. Jim, WB6MQE, Zip code 91754. (213) 280-8202.

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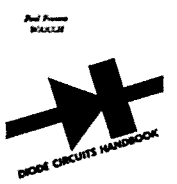

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R-274/FRR RECEIVER, Hallicrafter version of SP-600-JX. All band, 500kc—54mc; good working order—$150 or best offer. Jim Cooper, 834Y Palmer, Maywood, N.J. 07607.

FREE: Lesson book "Mathematics for Electronics", "Fundamentals of DC" or "Fundamentals of AC". Please include 20¢ postage & specify title. Jim Cooper, POB 73, Paramus, N.J.

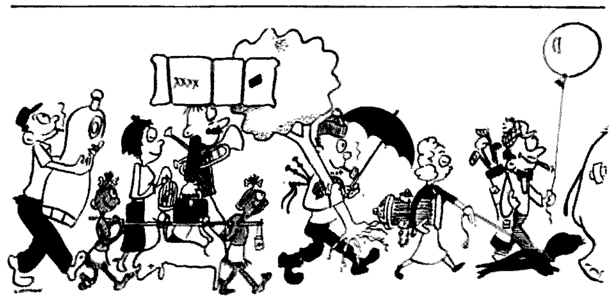
NEW BOOKS postpaid U.S. and Canada direct from author: "101 Easy Ham Radio Projects"—$3.95; "101 Easy Test Instrument Projects"—$3.95; "101 Easy Audio Projects"—$3.25; "104 Easy Transistor Projects"—$3.95; 'Electronic Hobbyist's IC Project Handbook" (contains 50 practical IC projects)—$3.95; "101 Easy CB Projects"—$3.25; "49 Easy Transistor Projects"—$1.75; "The VHF Amateur" (contains 33 easy VHF projects)—$4.50. Check or money order to: Bob Brown, K2ZSQ/W9HBF, 5611 Middaugh Ave., Downers Grove, Ill. 60515.

LONG RANGE TV reception easy! Booklet outlines methods to receive distant TV stations using inexpensive materials. $1.50 postpaid. Practical Plans, Box 56-K, Killeen, Texas 76541.

WANTED: Used 2 meter AM transceiver with squelch, also two meter low power linear amplifier, also 2 meter preamp. John Stiles, Sweetgrass, Montana 59484.

UFO'S. Sell collection of 50 paperback books, 3 hard cover, NICAP & others, plus 2" pile of clippings collected over recent years. Very fine collection material. Make offer. Wells Chapin W8GI, 2775 Seminole Rd., Ann Arbor, Michigan 48104.

QUARTZ CRYSTALS for two-way communications, Motorola, General Electric, RCA, Comco, Aerotron, and others. To order send desired frequency, manufacturer's make and model. American Crystal Co., Box 2366, Kansas City, Mo. 64142.



Moving? Please Let Us Know!

AMATEUR RADIO 73

February 1969

75¢

Fast Scan Vidicon for SSTV

Selective Audio Filter

The Unijunction Transistor

SPECIALS

The Life of Nikola Tesla
Master of electrical energy

Part I — Getting Your
Extra Class License

73 MAGAZINE

February 1969
Vol. LXIX No. 2

STAFF

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Editor

Wayne Green W2NSD/1
Publisher

William Beatty
Advertising Manager

Cover Photo: The new Hallicrafter's SR-400 Transceiver with companion HA-20 External VFO. The little robot in the foreground is "Ampheham," built almost entirely of Amphenol connectors of various types. See story on page 76. This could lead to all kinds of projects to keep those spare connectors busy!

Editorial Comment: Postal regulations require that a postcard insert in a magazine must be assigned page numbers. In this issue there is a card between pages 32 and 35, so don't panic after you tear out the card and assume there are two missing pages in your issue.

Contents

Departments

73 Magazine is published by 73, Inc., Peterborough, N.H. 03458. Subscription rate: $12.00 for Three years, $6.00 for one year. Second Class Postage paid at Peterborough, New Hampshire, and at additional mailing offices. Printed at Pontiac, Illinois, U.S. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.

Editorial Liberties

They say "Imitation is the sincerest form of flattery". Apparently, one of the other magazines likes our cover format and copied it for their December issue. However, the advertisers must be delighted that their Xmas ads arrived on the scene after Christmas!

The illness which seems to have hit amateur radio recently is disturbing, to say the least. We hear obscene language (and I don't mean an occasional "damn" or "hell"), music, tape recordings, and a multitude of violations of both amateur rules and *just plain ethics.*

These are sick people! Incentive licensing is not the answer to this kind of problem. Personality defects can't be cured by knowing more about electronics, or being able to copy faster CW. There must be a form of screening for new hams. Obviously, FCC can't have a Psychologist in each office to decide whether a potential ham is going to create problems on the bands.

The thought occurs to us that perhaps the ham club could participate in the decision.

What would happen if a potential ham was required to have character references from a minimum of three other amateurs before he was permitted to take the exam? Taking it a step further, these references would be checked against the OO files at ARRL, to see if the references themselves were clean. If all seems in order, ARRL would recommend that the applicant be allowed to take the exam. If not, the request would be denied.

Even with Incentive Licensing, we make it entirely too easy to obtain a ham ticket, and very hard to lose it. FCC does not have sufficient personnel to monitor the amateur bands with any degree of efficiency. We are pretty much left to police our own bands and unless FCC receives a complaint, they don't take action. The ARRL Official Observer system is a good one, but has no real authority for action.

The ham clubs have been complaining for a few years that interest has been waning. Here might be the opportunity to give the club a real purpose. I think it might be a good thing to have every ARRL OO report be directed to the attention of a committee of the nearest affiliated local ham club for investigation. If the ham in question has a bad record with his local hams, ARRL could then recommend that FCC take action. We have a lot of housecleaning to do in our ranks.

It was once said, "Let he who is without sin cast the first stone." I have, and I'm sure most of us, have, on occasion, violated some of the rules. I once, while mobile, called CQ out of the band. We all, at some time or other, inadvertently, make mistakes. These isolated violations would not need to be included. However, where deliberate infractions of the regulations were involved, a hearing would be called by the local club. The results of this hearing would be forwarded to ARRL and FCC.

This month, I have taken the liberty of devoting a good portion of 73 to an article on Nikola Tesla. If this name means nothing to you, you would be well advised to read the article. Tesla's AC theory probably advanced the state of the art of electricity and electronics by at least twenty years. This article, lengthy as it is, tells only a part of the story. The reference list which follows, is one worthy of attention.

Also, this issue begins the Extra Class theory course. This follows the same format as the Advanced theory which has run in 73 for the past year. Apparently people *do* want to learn, rather than memorize. The response to this series is overwhelming! We will continue to devote space to tutorial articles as long as the demand is present. Maybe I'm wrong, but it seems to me the role of the ham magazine is not just "How to do it," but "Why it happens."

. . . Kayla—W1EMV

.....de W2NSD/1

The proof of the pudding is in the eating, if I may coin a phrase, and the proof of the value of incentive licensing is in the results that it brings to amateur radio. The incentive licensing rules were announced over a year ago and there certainly has been time enough for a pattern of response to the new rules to emerge.

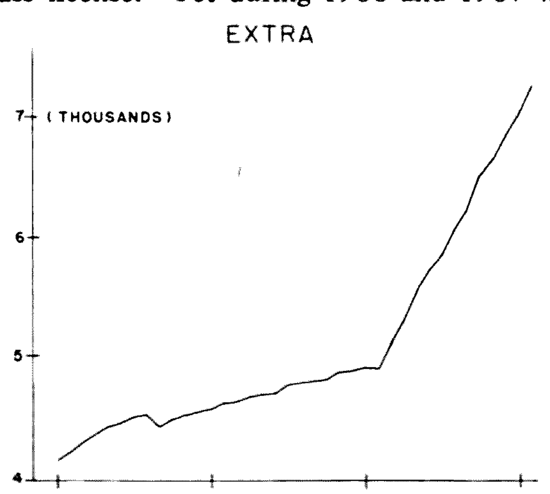
The new allocations for the Extra Class license came as a shattering blow to most DX hunters and contest fans. With the bottom 25 kHz now the exclusive Extra Class country this meant that virtually all of the DX hunting grounds were out of bounds for the other classes. The letters column in QST gave clear evidence that the amateur reaction to this was one of enthusiasm and determination. Everyone was buckling down and going to pass the new license exams.

Now that the facts are in we can see that the new licenses were met with massive apathy and resignation. There is little sign of any enthusiasm. Let's take a close look at the curve of the FCC released license figures and see what has happened.

As early as 1963, when the ARRL central Committee started the incentive licensing ball rolling, it was obvious that there were going to be some advantages to having the Extra Class license. Yet during 1966 and 1967 we see the number of EC's growing at about 500 a year, with a total of only 5000 at the end of 1967; many grandfathered into the license. Then, with the release of the new allocations, the curve changed and some 2000 new EC licenses were issued during 1968. This is about 1500 over the normal growth of the license, or about ½ of 1% of the 260,000 licensed amateurs.

It would be hard to envision a more devestating rejection. Amateur radio has flatly turned thumbs down on incentive licensing so far. Now that the new allocations have actually gone into effect we may see more of a rush for the EC license. Let's hope so, because our EC bands are just sitting there largely unused except for the DX stations now and our experience is that while nature abhors a vacuum, the commercials love it and are quick to fill in any blank spots we leave in our bands. And once in, it is almost impossible to get them back out again.

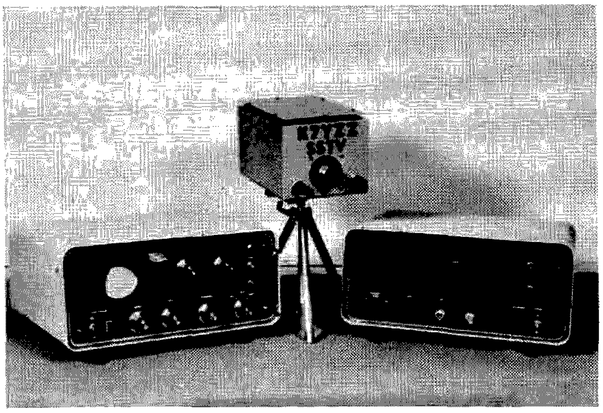
Why has the Extra Class license been turned down by the amateurs so far? The letters we receive indicate that most amateurs are put off at having to take what seems to them to be a professional exam for an amateur license. The theory part of the exam is quite comparable to the theory part of the First Phone Commercial License exam and the 20 wpm code test also seems "com-



(More of this on page 77)

A Fast-Scan Vidicon In The Slow-Scan TV Camera

Louis I. Hutton K7YZZ
12235 SE 62nd St.
Bellevue, Wash. 98004



With the successful construction of the Slow-Scan TV (SSTV) Picture Generator described in 73 magazine,[1] I decided to try my hand at building a SSTV Vidicon camera. I had previously built a conventional TV Vidicon camera of the type described in ATV Anthology.[2] I soon found that Slow-Scan Vidicons are expensive and scarce on the surplus market. Since I am not able to locate an available economical source of this type of Vidicon I decided to try to use a fast-scan Vidicon in the slow-scan mode. The camera described in this article is based on the design by Macdonald WAØNLQ,[3] but incorporates extensive circuit redesign of the video amplifier to permit the use of a standard fast-scan Vidicon operating in the shutterless slow-scan mode. The camera consists of two units, one the camera head, and the other the power supply, sweep circuits and sub-carrier modulator/oscillator.

[1] "A Slow-Scan TV Picture Generator", K7YZZ, 73, October 1967.
[2] "ATV Anthology", 73.
[3] "A Slow-Scan Vidicon Camera", Macdonald, QST, June, July, August 1965.

Camera head

To minimize stray magnetic field pickup the Vidicon, deflection coil assembly, 10 kHz video amplifier and detector were mounted in a steel cabinet 5" x 6" x 9". The shutter mechanism was omitted and a spacer made from sheet brass was installed between the cabinet front panel and the focus coil to provide the proper focus distance (25mm in my camera) between the lens and the face of the Vidicon. A fixed focus 16mm lens, Bausch and Lomb F2.7 to F16 - FL 25mm, was mounted to the front of the camera head. This lens was purchased from Burstein-Applebee and is their part number 61A78 in the 1967 catalog. The "Beam", "Video", and power plug are mounted on the rear of the camera head. The box lid is spaced one quarter inch from the box by metal standoffs to provide adequate cooling.

Comparing the circuit diagram of the camera head with the circuit of the Macdonald SSTV camera the reader will note the change of V13 and V14 to more common tube types and the addition of a tuned circuit to limit the bandwidth of the

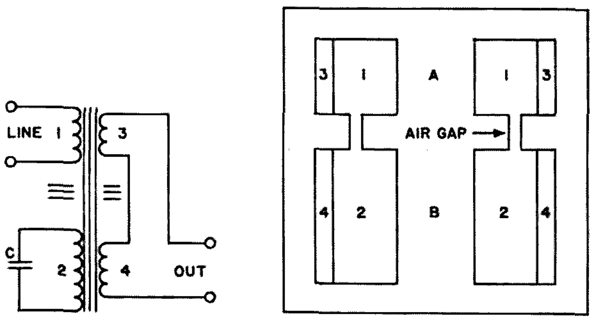


Fig. 1. Driving and control circuits mounted in the camera box.

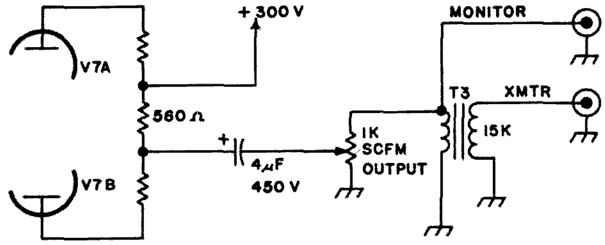


Fig. 2. Audio output control circuit.

10 kHz video amplifier. Several other component values were changed to optimize the new amplifier design.

The deflection yoke and focus coil assembly were handmade. Information on the techniques of making Vidicon deflection components may be found in the ATV Anthology. The focus coil was wound with #32 wire and has a dc resistance of 420 ohms.

Due to the lower vertical and horizontal sweep frequencies used in SSTV the deflection coils contain many more turns of wire than those used in fast-scan TV. The vertical deflection coils series dc resistance is 360 ohms, using a coil form window spaced of 11⁄16" x ¾" x .050" thick, with #36 wire. The horizontal deflection coils series dc resistance is 270 ohms, using a coil form window spacer of 1⅟16" x ¾" x .035" thick, with #36 wire. For those individuals not interested in winding their own coils, a kit of prefabricated deflection components for SSTV cameras may be purchased from ATV Research advertised in 73 magazine.

Main chassis

The remaining portions of the SSTV camera were built on a hand formed chassis housed in a Heath cabinet. The shutter control circuitry (V8a and V8b of the QST schematic) may be deleted if the builder does not plan to acquire the 7290 SSTV Vidicon. The 1200 Hz phase setter (V15) was also deleted as suggested by Macdonald. A 1000 ohm potentiometer was added to control SCFM audio output (Fig. 2).

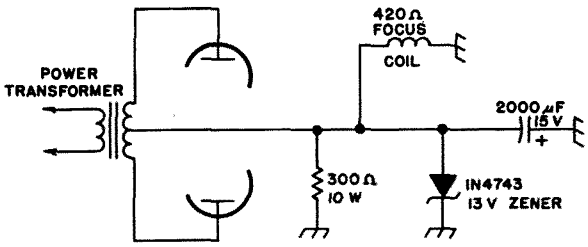


Fig. 3. After some experience with the focus coil circuit, a zener regulator was added as shown here.

The focus coil was wired as shown in the original schematic but has since been changed as shown in the schematic of **Fig. 3.** A 1000 ohm potentiometer connected in series with a 470 ohm resistor was wired across the horizontal output deflection coils terminals to provide for control of horizontal sweep width.

A test point was brought out accessable from the top of the chassis from pin #7 of V6b to aid in camera tune up and adjustment.

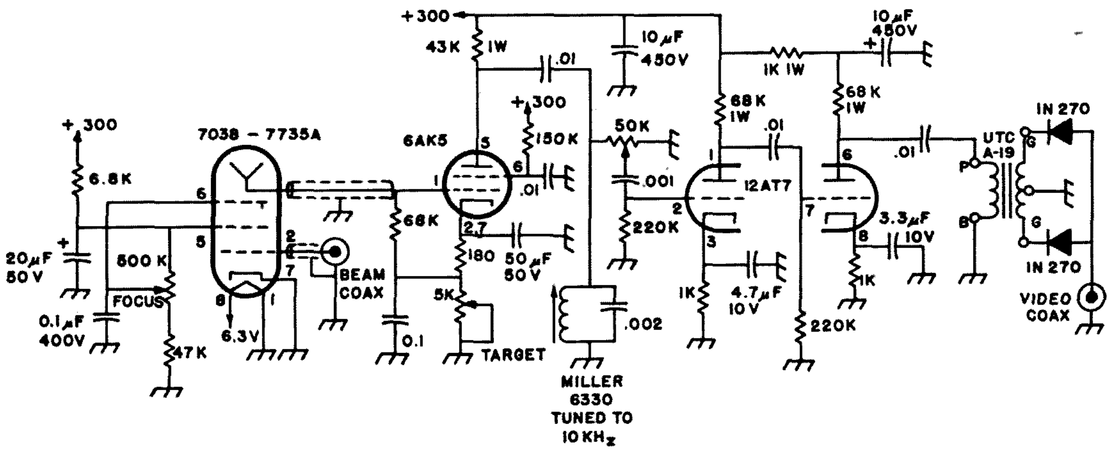
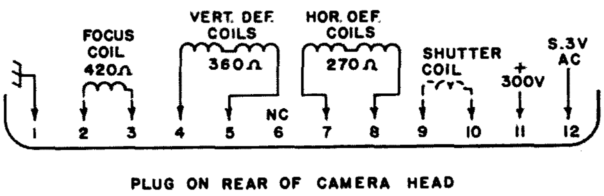
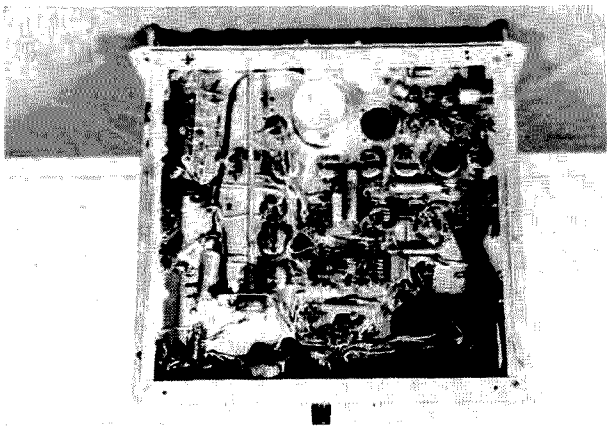
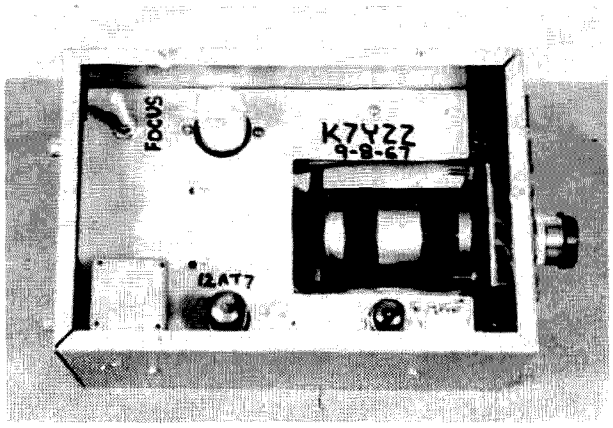


Fig. 4. Complete wiring diagram of the SSTV camera head. Note: pins 9 and 10 blank if shutter deleted on camera using standard vidicon.

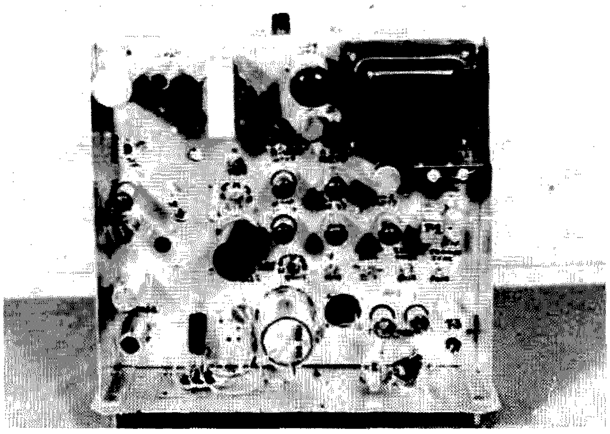




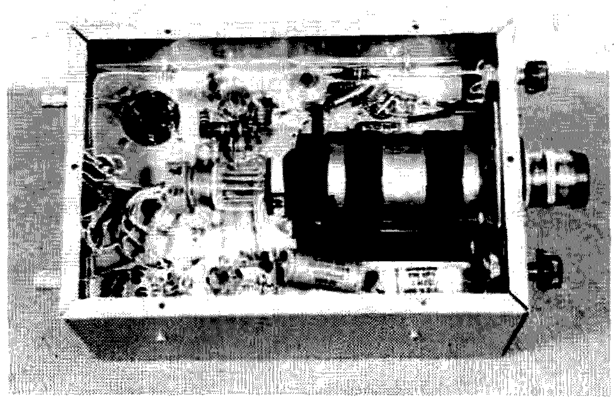
Bottom view camera power and sweep.



Top view of camera head.



Top veiw, camera power and sweep.



Bottom view of camera head.

Adjustment

The detailed adjustment of a SSTV camera is described in the original Macdonald article. Of course those portions referring to the shutter operation do not apply to this camera.

Typical operational voltages on the 7735A SSTV camera head are as follows:

Target: plus 9 to plus 15 volts
Beam: minus 87 volts
Focus: plus 160 volts
#5 pin on 7735A: plus 300 volts
Contrast: mid rotation

The first recognizable picture observed on the camera was reversed. This was corrected by reversing the horizontal deflection connections at the camera head power plug. The deflection yoke also required some minor rotation to level the picture. Optical focusing of the camera is accomplished by changing the position of the Vidicon. With the fixed focus lens referred to earlier in this article I am able to view objects in focus from around 2 feet to 20 feet.

For station identification titles I use a movie titler. This Sears catalog #3 G9350C Magic Master Letters for titling, uses white plastic letters on a black background, and is held approximately three feet from the camera for full coverage.

Live subjects may be scanned, but the individual should remain motionless for about 24 seconds for a good clear picture on the SSTV monitor.

I wish to express my thanks to Copthorne Macdonald, WAØNLQ, for his verbal assistance during the construction of the camera, and to Bob Gervenack, W7FEN, for his cooperation in the on-the-air tests of the camera.

. . . K7YZZ

A Cheap and Simple, Tri-Band, Linear Amplifier

Allan H. Matthews WB2PTU
R.D. 1,
Waverly, N.Y.

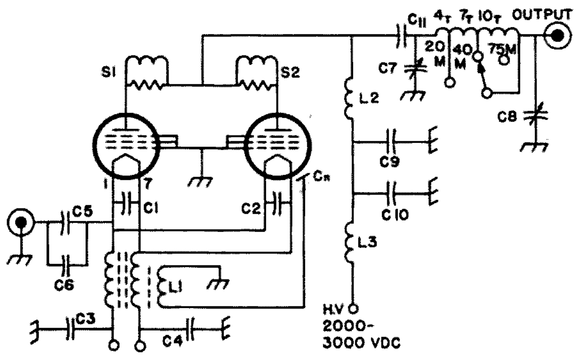


Fig. 1. Schematic diagram of the "Cheap and Simple Tri-band Linear Amplifier."

This article is not for the ham who buys all new commercial gear. He can go out and purchase a nice, new, shiny, chrome-plated linear amplifier for a few hundred bucks and be on the air fast with his 2000 watts PEP. If you are the type of ham, however, who believes in a little elbow grease and ham ingenuity, read on friend, and save some money. 80, 40, and 20 meters are covered because these are the bands most transceivers cover.

I had recently traded all of my gear and purchased the SB 34. This left me with no money for ham gear but with a desire for a higher power, at least for 75 meters. I decided that the linear amplifier must have the following specifications:

1. No screen voltage supply.
2. No bias voltage supply.
3. 500 to 1000 watts dc input.
4. Low cost.

My choice of tubes was a pair of 813's. These are available as surplus from many sources and many amateurs have a few kicking around. Some commercial stations use them for drivers and the ART-13 also used one, so look around. The tube socket is cheap and no fancy blower is needed. Since the SB 34 would deliver 135 watts PEP I decided on the grounded grid circuit. I realize that some commercial amplifiers use 813's in grounded-grid with a bias voltage, but, believe me, they work very well with all grids tied together and strapped to ground. This also saves a few capacitors and a bias supply. The schematic pretty much explains things, but don't be afraid of substitutions. The filament transformer can be a rewound television power transformer. 10 volts at 10 amperes is what is needed if you wind your own. Don't forget the center-tap.

The filament choke is used to block rf from getting into the filament transformer and to ground. You can purchase one for about $18 or wind your own for about 25c. I wound my own. The core is ferrite from the core of a burned out television fly-back transformer. Grind the U shaped piece until you have a straight bar of the material, then give it a coat of Scotch #33 tape to smooth it off. Next, wind one layer, 12 turns, of #12 wire, the wire arranged to be two windings wound simultaneously. To do this fold the wire in the center, clamp it into a vise, stretch it and then wind the choke using both strands, side by side. It requires about ten feet of wire. Use Formvar insulated wire if you can get it. Motor rewinding shops have it on hand. After you have wound the core full, give it another layer of tape. Then wind a single strand of anything from # 16 to # 26 in the same direction directly over the tape, using the same number of turns as you used on the first winding. This will be used for neutralizing. Cover this winding with plastic tape also.

The next expensive item is the kilowatt tank coil. I wound my own, using 15 ft of ⅛ in. copper tubing. My coil is 2¾ inches inside diameter because that's the size can I had on hand. Some pieces of plastic and some plastic cement were used to space the

Parts list

C1, C2, C3, C4	.01 *mfd.,* 600 *V. ceramic*
C5, C6	.006 *mfd.,* 1200 *V mica*
C7	240 *pF,* ⅛ *inch spacing*
C8	1000 *pF*
C9, C10	500 *pF TV doorknob*
C11	.0024 *pF* 5000 *V.*
Cn	*See text.*
L1	*See text.*
L2	*P & H kilowatt plate choke, or equivalent.*
L3	20 *turns* #26 *on* ⅜ *inch dowel, close spaced.*
S1, S2	5 *turns* #16 *on* 47 *ohm* 2 *W resistor.*

windings at about 1⁄16 inches apart. The coil I wound has 21 turns, but 18 would be plenty, as I tried a second tap for 75 meters but it didn't make any difference. Total cost for the coil was under two dollars. The L/C ratio is probably not exactly right but with 1000 watts of dc input, who cares if we lose a watt or two. Besides that, the coil runs cool. So much for the purists.

The amplifier was built for 75 meters but a rugged rf switch from an old tuning unit was in the junkbox and since the SB 34 covered four bands, I decided to make the unit bandswitching. I used a grid dipper to find taps on the coil so the linear would operate on 75, 40, and 20. Taps are as follows:

40 meters . . . 11 turns from the plate end of the coil
20 meters . . . 4 turns from the plate end of the coil

The power supply is conventional and since mine is rack mounted, the power supply control panel contains the 0-500 mA meter and the 3.5 kV plate voltage meter. That way, if I build another linear, I save the price of two meters. I use a variac in the plate transformer primary, but light bulbs in series will work as well to get tune up voltages.

Earlier I mentioned substitutions and here are a couple you will probably make. The plate tuning capacitor is a 240 pF Cardwell but a 150 pF would do the trick. The loading capacitor is another ancient Cardwell (I think it is 1000 pF but I'm not sure) and you might do better with a three gang broadcast variable. This would be about 1100 pF.

Tune up procedure is to warm up the tubes and apply about 1000 volts to the 813's. Tune the exciter and the linear for maximum output. This will be about 300 mA of plate current at 1000 volts. Then take out the carrier and raise the voltage to whatever is available. Operate the linear at 2800 volts at 320 mA for an input of 900 watts dc. Adding the driving power of 90 watts dc of the SB 34 we wind up with very close to the legal limit. Idling current of the two tubes runs about 60 mA.

Neutralization is not critical and perhaps not necessary. C_N is an antenna connector from an Arc-5 but a piece of stiff wire would work as well. There is no need for adjustment.

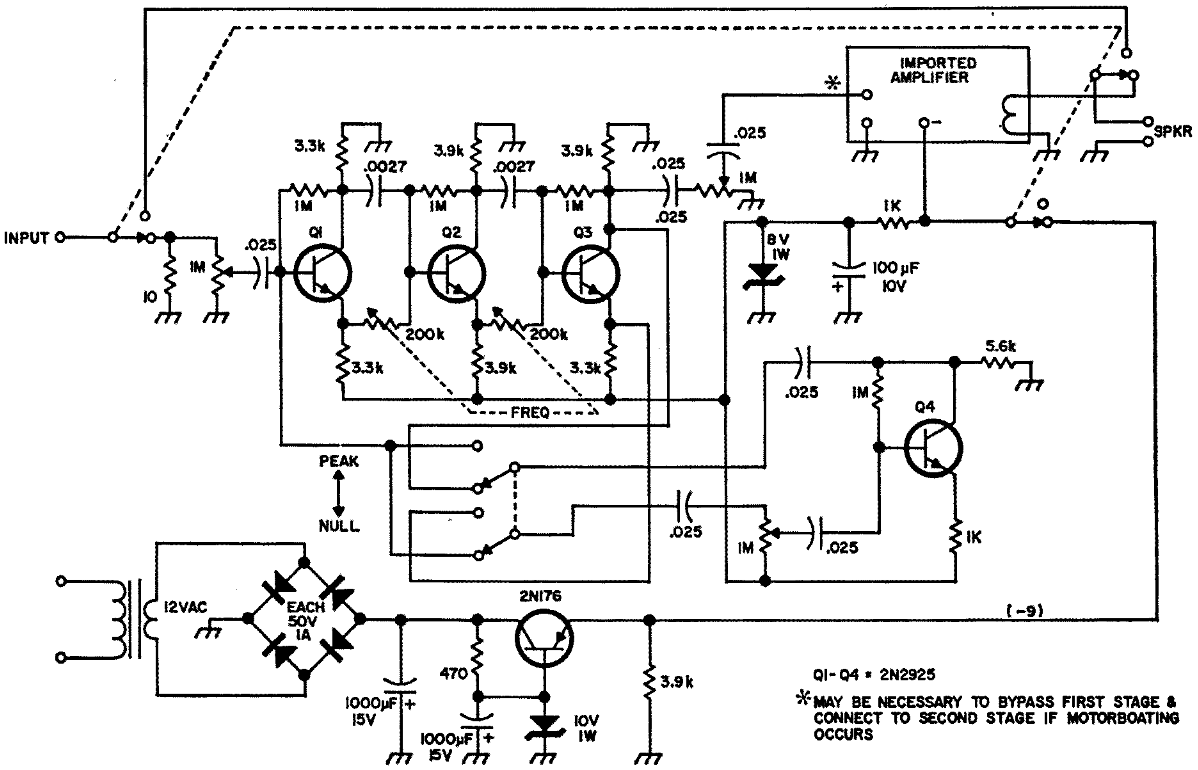
In closing, let me say that I scrounged most of the parts for this linear amplifier, and what I didn't scrounge, I built. So can you. I have much less than $20.00 in the amplifier itself. The signal reports are gratifying (about 10-12 dB above the barefoot exciter) and this unit can be heard nightly at 3955 kHz where I will be in QSO with K3ABC . . . Break in and join us.

. . . WB2PTU

The Beatnote Basher

Roger Melen WB6JXU
Rt. 2, Box 486-M
Chico, Calif. 95926

A Selective Audio Filter

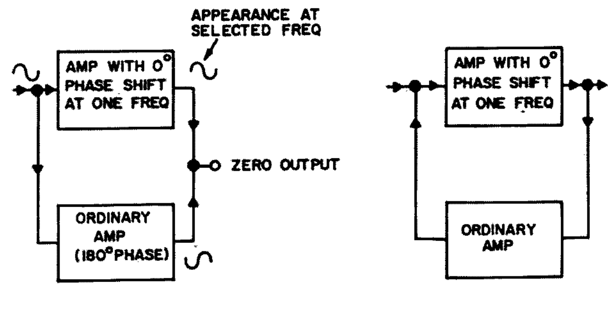


Today's crowded amateur bands require selective receivers. Heterodynes, ignition noise and other interference can wreck a good QSO. Unfortunately, some modern SSB transceivers don't have a notich filter, and aren't selective enough for good CW reception. The "Beatnote Basher" is not a cure-all, but it does offer, in the "reject", mode an audio notch that will knock an undesired heteroydne almost out of the picture. In the accept mode, it proves an extremely sharp passband allowing you to pull a single station out of a pile-up. Also, the installation requires no modification of your present equipment. It is simply installed in the speaker lead of your present receiver, or transceiver. It works with all *if*s, and receivers and tranceivers.

Basically, the idea is not new. The "selectojet"[1] and others are based on the same principal. An audio amplifier is constructed so as to have a phase shift of zero degrees at just one frequency. Q_1, Q_2, and Q_3 comprise such an amplifier. An ordinary amplifier, Q_4, is the placed in parallel with before-mentioned amplifier when the "accept-reject" switch is placed in the reject mode. The ordinary amplifier, which has a phase shift through it of 180 degrees, will have an output which is identical to the phase shifting amplifier except for a phase difference of 180 degrees at the frequency which is to be rejected. If the selectivity control is adjusted so that the gain of both amplifiers is identical at the frequency which is to be rejected, the two signals will add out, while allowing all others to pass through.

In the reject mode, the "Beatnote Basher" acts as an amplifier with feedback, but the feedback is at the optimum phase at just one frequency. The system has greater gain at this frequency than at all others, so that only the desired frequency is heard at the speaker.

Most circuits of this sort utilize a tube type amplifier. Warm-up time, heat dissipation and size were the main factors which



ACCEPT MODE REJECT MODE

discouraged the use of tubes in the author's circuit. The transistor which should be used is rather important. Impedance matching, gain and other consideration point to a high beta transistor. The General Electric 2N2925 has a typical beta of 215 which is excellent for our purpose, and they're only 60c each.[2] Bargain transistors of dubious type are not recommended. The audio amplifier may be any of the 1 watt or 3 watt imported jobs which are presently on the market.[3] The author attempted to homebrew an amplifier, but turned to an imported model when interstage and output transformers were found to be going for the same price as the complete imported amplifier. Any suitable power supply can be used, as long as it is capable of being hum free at currents up to a half an amp or so, depending on the power output of the imported amplifier obtained. Without the amplifier, the current consumption is about 4 milliamperes.

Construction technique varies with the builder, and nothing is extremely critical, although good wiring technique is always advisable. The unit in use here is constructed on a vectorboard with flea clips. Sockets are recommended for the transistors. Presently, the power supply and filter are in separate mini-boxes, but plans are being made to fit the whole thing in one 7" x 5" x 3" mini-box. The front panel controls are: power, in-out, reject-accept, frequency and selectivity. The two gain controls may be put on the back panel, or once the desired values are found replaced by fixed resistors. The filter should be in a shielded box in order to void picking up *rf*.

Once the unit is biult, the input should be connected to the speaker jack and the output to a speaker. With the selectivity control set for maximum gain and both gain controls set for maximum gain and the "accept-reject" switch put in the accept mode, the unit should oscillate quite loudly (tuning the frequency may be needed) and it is not recommended that this be done when others are sleeping). Backing down on the selectivity control should stop the oscillation.

The gain control for the imported amplifier should be adjusted so that the amplifier is not distorting badly. With audio fed into the filter, the selectivity control backed all the way down, the gain control on the input of the filter should be backed down below where distortion occurs. If output is lacking, gain control on the imported amplifier may be adjusted for more gain. For most shacks a 1 watt amplifier is sufficient, but the 3 watt model may be preferred. When finished, the gain controls should be set so that when the filter is put in it has no gain or loss when the selectivity is all the way down and it is in the accept position.

With the filter "in" a signal may be notched out by putting accept-reject switch on "reject" and tuning the frequency until the heteroydne is nulled. The selectivity control should be set about half or two-thirds of maximum for this operation. Once the null is achieved, the selectivity control should be tuned for maximum null.

A signal may be peaked by putting the accept-reject switch on accept and advancing the selectivity control to the threshold of oscillation. The frequency control is turned to peak the desired frequency. The selectivity may have to be readjusted some while turning the frequency control. The operation of the unit is very similar to a Q multiplier except that it operates at audio frequencies in the speaker lead.

The unit may be built into a receiver and then the imported audio amplifier could be omitted, and the output of the filter hooked to the input of the receivers audio.

If properly wired the unit should give no difficulty and serve as a useful receiving accessory. It can also be useful as an audio oscillator when the selectivity control is advanced in the "accept" position. Oscillator output can be taken at the input to the imported amplifier. . . . WB6JXU

[1] 1963 *The Radio Amateur's Handbook* page 129

[2] Newark Electronics Corporation, 500 Pulaski Road, Chicago, Ill. 60624

[3] Lafayette Radio Electronics, 111 Jericho Turnpike, Syosset, L.I., New York 11791

The Unijunction Transistor

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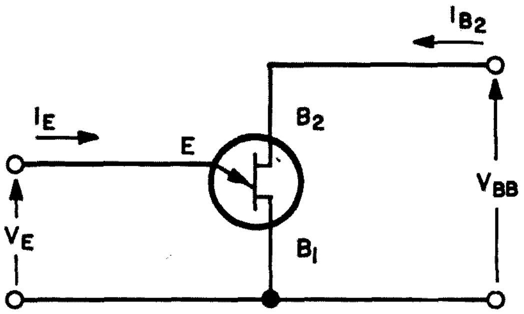

Fig. 1. The symbol and conventions for current flow in the Unijunction transistor.

Perhaps you have seen this rather unusual name in technical journals. Perhaps you have seen an odd-looking symbol (see **Fig. 1**) in a circuit in those very same technical journals. Perhaps you have wondered what this little device does—with its symbol that vaguely resembles that of a conventional transistor but actually behaves much differently. The thing looks (and behaves) like some weird paradox—it has an emitter in the wrong place and *two* (yes two) bases —which incidentally gives us its other name —"The Double-Base Diode," which tends to confuse matters even further.

Well, what is this little device and what can you do with it? Read on, and all shall become clear (or more confused).

The unijunction transistor (hereinafter referred to as UJT) is a semiconductor device possessing quite unusual electrical characteristics. Its construction and operation is markedly different from the conventional two-junction transistor.

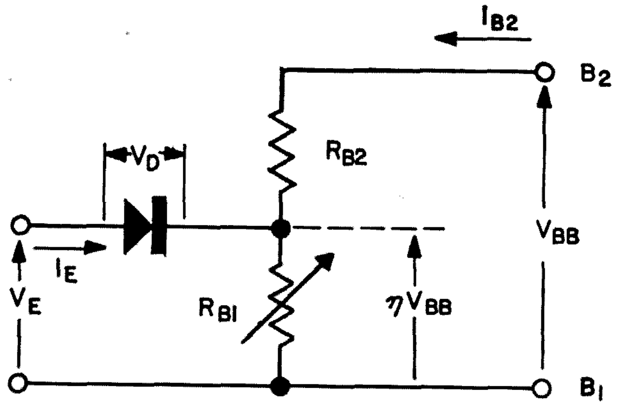

Fig. 2. A simplified equivalent circuit where R_{B2} plus R_{B1} represents the resistance between B_2 and B_1.

Characteristics

Fig. 1 shows it's symbol and the conventions for current flow in the device. **Fig. 2** gives a simplified equivalent circuit. Now, referring to **Fig. 2**, R_{B2} plus R_{B1} represents the resistance between B_2 and B_1. This is known as the interbase resistance, R_{BB}, and is generally in the range 4K and 12K ohms. This is the resistance of a bar of N-type silicon with two contacts at either end. Now another contact of P-type material is placed somewhere between B_2 and B_1 on the N-type silicon bar and this forms a rectifying or diode contact called the emitter (E).

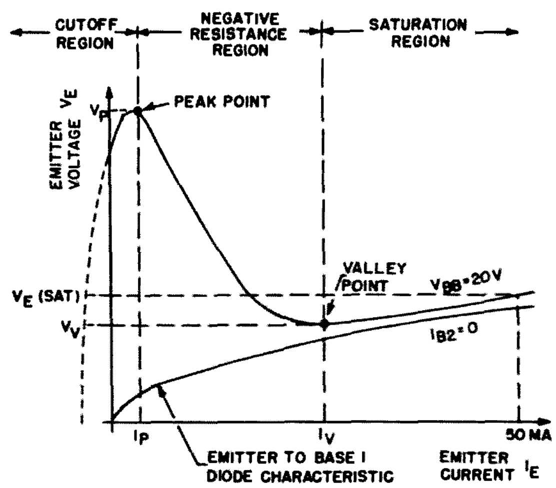

Fig. 3. Plotting the interbase characteristics.

Intrinsic standoff ratio

If a variable potential is connected between B_2 and B_1, with the positive on B_2 and the negative on B_1 (E not connected to anything) the device acts just like a voltage divider and a certain fraction, will appear at the emitter (E). This fraction (η) is called "the intrinsic standoff ratio". The ratio is approximately 0.5 to 0.8 for all types of UJT's. Mathematically the following equation will accurately define η.

$$\eta = \frac{R_{B1}}{R_{B1} + R_{B2}}$$

Peak point emitter voltage

If the emitter Voltage, V_E, is less than V_{BB}, the emitter diode is reverse biased and only a small leakage current will flow. As V_E is raised towards V_{BB} and just above, emitter current will flow as the emitter diode becomes forward biased. The result is that R_{B1} will suddenly decrease its resistance. Consequently I_E will suddenly increase and V_E will drop.

The point at which R_{B1} suddenly decreases is called the "peak point" and the emitter voltage at this point is called the "peak point emitter voltage" and is labelled V_P.

The diagram in **Fig. 3** illustrates the peak point and V_P a little more clearly. These are the static emitter characteristics and you will note that V_P is dependent on V_{BB} (the interbase voltage.) The lower curve (I_{B2} = 0) is the emitter to B_1 diode curve when B_2 is disconnected. These curves can be plotted for any UJT by breadboarding the circuit in **Fig. 4.** Set V_{BB} to convenient voltage in 5V or 10V steps and for each setting of V_{BB} vary the emitter pot. to find V_P first (sudden increase in I_E) and then vary I_E in suitable steps (about 1 or 2 mA steps), reading V_E at each step. You can then plot the static interbase characteristics like those in **Fig. 3.** Disconnecting B_2 will allow you to plot the curve for $I_{B2} = 0$.

From these curves an approximation to η can be calculated very easily. Simply divide V_P (for a certain value of V_{BB}) by the value of V_{BB} for that curve—

Now V_{BB} = 30 V, lets say V_P = 16 volts. at this point

$$\eta = \frac{V_P}{V_{BB}} = \frac{16}{30} = 0.534$$

To be more accurate at lower values of V_{BB} use the equation—

$$\eta = \frac{V_P - V_D}{V_{BB}}$$

where V_D = emitter diode voltage, $\approx$ 0.6 volts

Peak point current

This is marked as I_P in **Fig. 3.** I_P is the minimum current necessary to trigger the UJT. It can be measured using **Fig. 4** with some changes. Disconnect the meter (VTVM etc.) reading V_E. Replace the meter reading I_E (0-50mA) with a 0 to 50 microammeter. At each setting of V_{BB} slowly increase the emitter potentiometer until the meter jumps suddenly. The point just before the jump in emitter current is the value of I_P.

Valley voltage

This is marked as V_V on **Fig. 3.** It is the emitter voltage at the valley point. V_V increases with increase in V_{BB} you may notice.

Valley current

This is marked as I_V on **Fig. 3.** It is the value of emitter current at the valley point, this also increases with increase in V_{BB}.

Static interbase characteristics

These characteristics are a series of curves that relate V_{BB} and I_{B2}. They can be plotted by breadboarding the circuit in **Fig. 5.** With the emitter disconnected at first, a reading of I_{B2} for every step in V_{BB} is taken. The steps in V_{BB} should be at 5V intervals. Then, connecting the emitter, increase the emitter pot. until the UJT fires and set I_E at

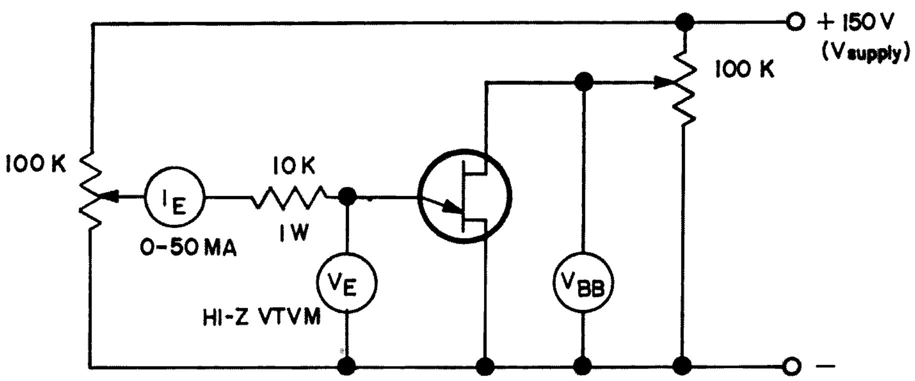

Fig. 4. The minimum current necessary to trigger the UJT can be measured. Keep V_{BB} constant at each step for variations.

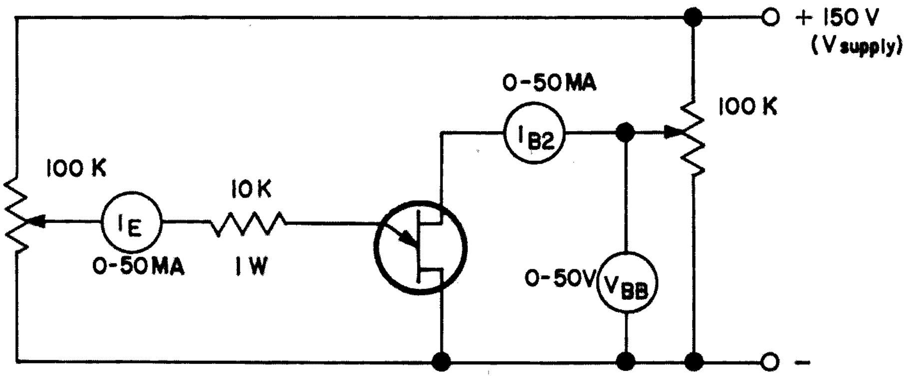

Fig. 5. Static interbase characteristics can be plotted by breadboarding this circuit.

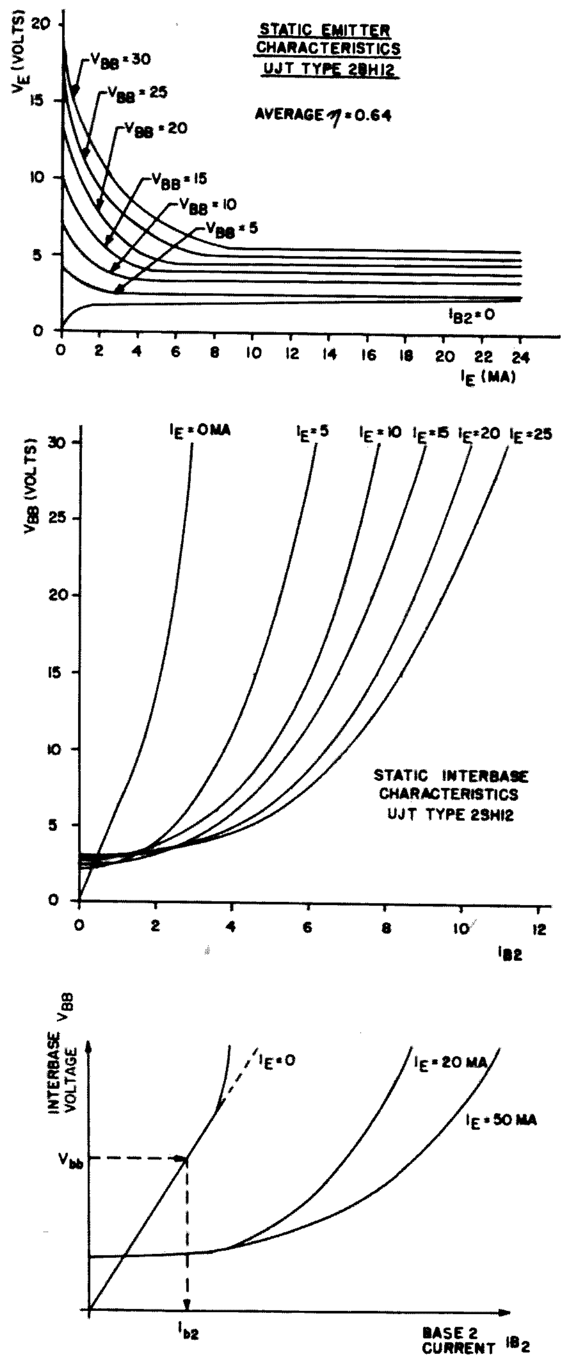

Fig. 6. Resultant curves from plotting by Fig. 5.

5 mA or 10 mA and keeping this constant, take readings of I_{B2} at every step in V_{BB}. Take another set of readings for I_E at say 10 or 15 mA. Continue this for steps of I_E at 5 or 10 mA intervals stopping at I_E = 50 mA. Plotting the results will give a set of curves like those in **Fig. 6.**

A set of curves was plotted, using the above methods, for a type 2SH12 UJT.

Construction

The UJT is constructed in two basic forms known as the bar and cube structures. Most UJT types are of the bar construction form.

The bar construction is shown in **Fig. 7.** A small bar of silicon has two ohmic contacts (not junctions) implanted at opposite ends of the bar. A junction (the emitter)

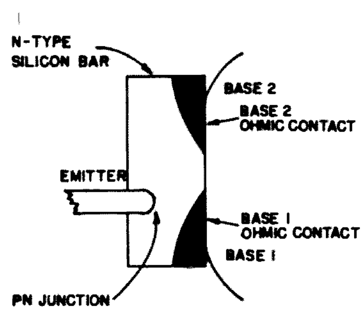

Fig. 7. Bar construction of most UJT types.

is implanted on the opposite side of the bar between B_1 and B_2. This junction is somewhat closer to B_1 than it is to B_2. The unit is generally mounted on a ceramic disc inside a TO — 5 or TO — 18 case and all leads are electrically isolated from the case.

The cube construction is shown in **Fig. 8.** The cube of N — type silicon is mounted on its base-two contact and the base-one contact is a thin wire alloyed into the top of the cube. The emitter is alloyed into the

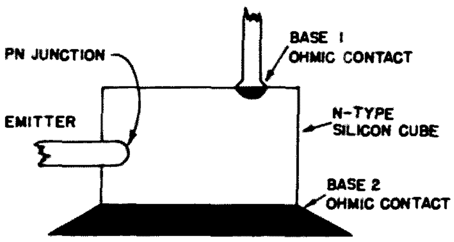

Fig. 8. Cube construction. This type is usually mounted in a TO—18 package.

side of the cube and a PN junction formed. This type of construction is usually mounted in a TO – 18 package.

This type of construction gives different characteristics to the bar type. Owing to the small contact area and shape of B_1 a higher intrinsic standoff ratio (n) can be achieved with much smaller spacing between E and B_1. This produces a lower I_P, short turn-on time, lower valley voltage, and permits operation at reduced voltages. Unfortunately cost is generally higher. **Fig. 9(a)** and **9(b)** illustrates the different static emitter characteristics of typical bar and cube structure UJT's.

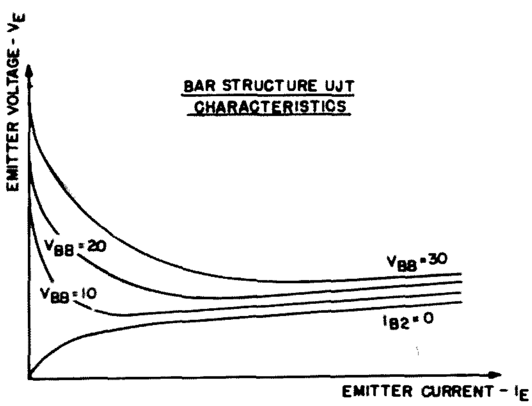

Fig. 9A. Characteristics of a bar type UJT.

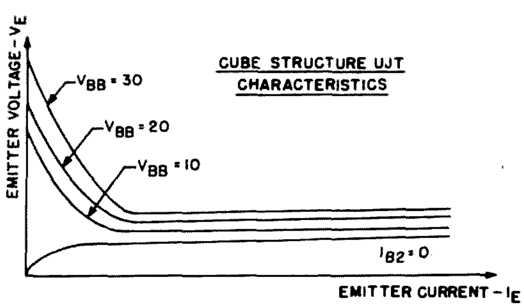

Fig. 9B. Chracteristics of a cube structure UJT.

UJT circuits

Seeing as most types of available UJT's are of the bar construction type I will only consider these in the following discussion.

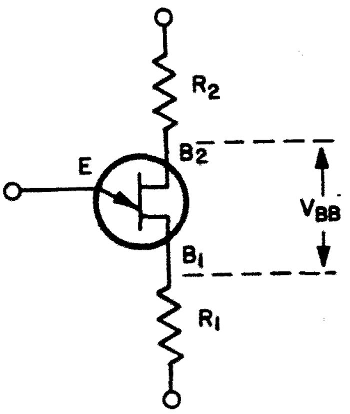

Fig. 10. Resistor R_2 compensates for temperature variations.

Bias circuits

The various parameters and characteristics of a UJT are subject to temperature variation; some more so than others. Now V_P will vary with temperature and is principally due to variation in V_D (see **Fig. 2**). This effect is usually compensated for by a resistor, R_2, in **Fig. 10.** As the temperature increases so will R_{BB}; V_{BB} will increase owing to the voltage divider action of R_2, R_{BB} and R_1.

The resistor R_2 can be chosen from the following equation

$$R_2 = \frac{R_{BBO}}{2\ V_1} \quad (\text{for } R_{BBO} \text{ see } \textbf{Fig. 6})$$

this equation is only approximate and some juggling of R_2 might improve the compensation, but generally it will be close enough for a wide range of UJT's. Also, for the circuit in **Fig. 10** V_P is given by: $-V_P = V_1$.

The resistor R_1 should generally be kept below 100 ohms as it controls the Valley Voltage (V_V) and Valley current (I_V) (see **Fig. 3**). Use what you have on hand.

Relaxation oscillators

The relaxation oscillator shown in **Fig. 11** can be used for many applications. For example; tone oscillator, timing circuit, pulse generator, sawtooth generator or a trigger circuit.

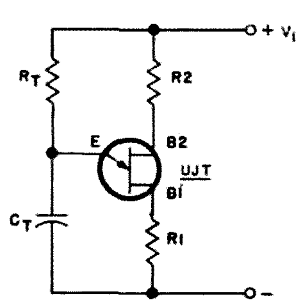

Fig. 11. The relaxation oscillator may be used for many purposes.

When V_1 is applied C_T appears as a short circuit and thus E is reverse biased and does not conduct. As C_T charges through R_T the emitter voltage rises exponentially towards V_1. When the voltage reaches V_P the emitter suddenly conducts and C_T discharges through E and B_1 via R_1.

The emitter then ceases conducting and the whole process begins again. The waveform produced is shown in **Fig. 12.**

The approximate frequency of oscillation is given by:

$$\frac{1}{R_T\ C_T\ I_n \dfrac{(\ 1\ )}{(1 - \eta)}} \text{ Hz}$$

the equation holds providing R_1 and R_2 are small ie. $R_1 \leqslant 100$ and R_2 from previous equation but less than 1000 ohms.

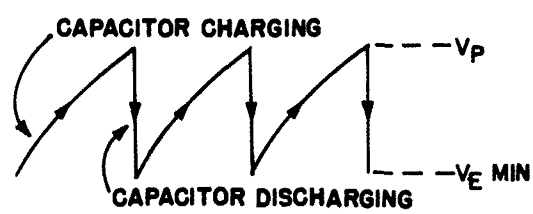

Fig. 12. Waveform produced from the relaxation oscillator.

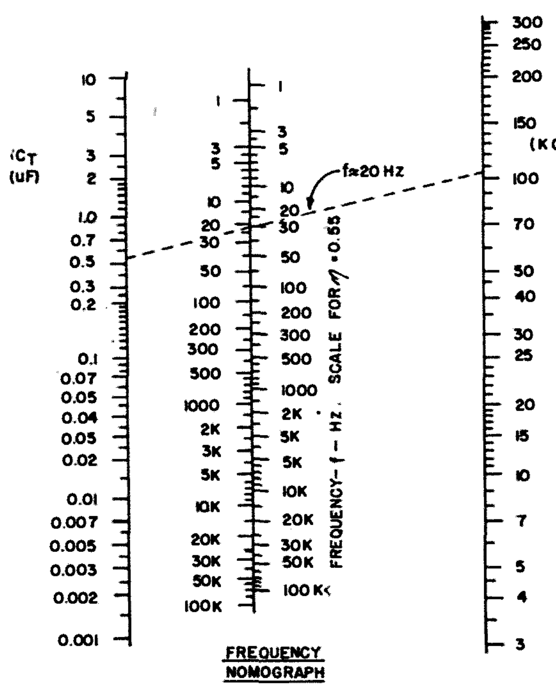

Fig. 13. Nomograph to assist in the design of a relaxation oscillator.

To save calculation in many instances a nomograph (**Fig. 13**) will assist in the design of a relaxation oscillator using a UJT.

Two frequency scales have been given. One for a value of $\eta = 0.55$ and another for a value of $\eta = 0.65$. Use the scale appropriate to the value of η for the UJT you are going to use. An example for a practical circuit is given later. (see **Fig. 16.**)

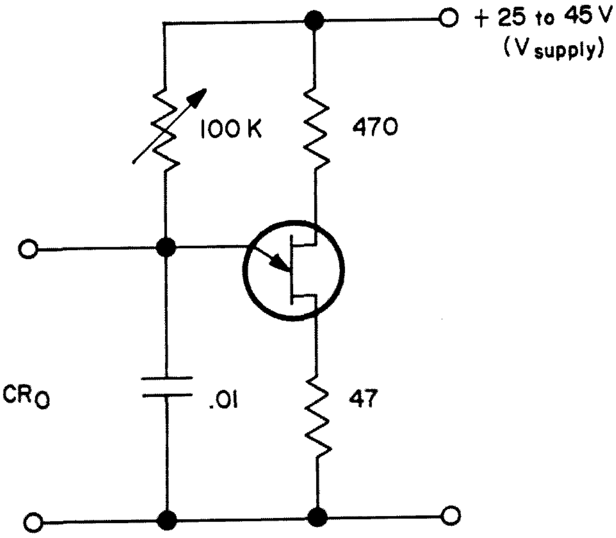

Fig. 14A. A practical circuit built and tested by the author.

A wide range relaxation oscillator

The circuit in **Fig. 14(a)** shows a practical circuit built and tested by the author. I used a Japanese UJT, the NEC-2SH12. It performed very well, the frequency range being 500 to 1. I inspected the waveforms with a Hewlitt-Packard CRO and the results are shown in **Fig. 14(b)** and **14(c)**. The circuit would not oscillate below 1kHz as the timing resistance R_T was too great to allow the emitter to "fire". The frequency is easily lowered by increasing C_T.

This circuit has great potential for the sweep generator in a CRO, rf sweep generator or Panaramascope. Unfortunately the output has a non-linear rise as can be seen in **Fig. 14(b)** and **(c)**. This can be overcome in two ways. **Fig. 15(a)** shows R_T returned to a higher voltage supply. This is OK and gives reasonable linearity providing a higher voltage supply is available. It suffers from a disadvantage though—the frequency is not as stable as it would be with a single supply.

In **Fig. 15(b)** a transistor, connected in a common-base circuit, uses the high output impedance of the circuit to maintain a relatively constant charging current for the timing capacitor C_T.

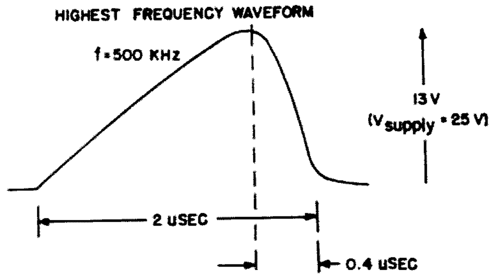

Fig. 14B. Highest frequency waveform.

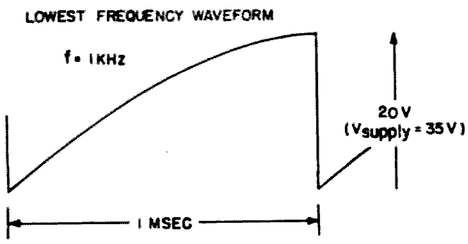

Fig. 14C. Lowest frequency waveform.

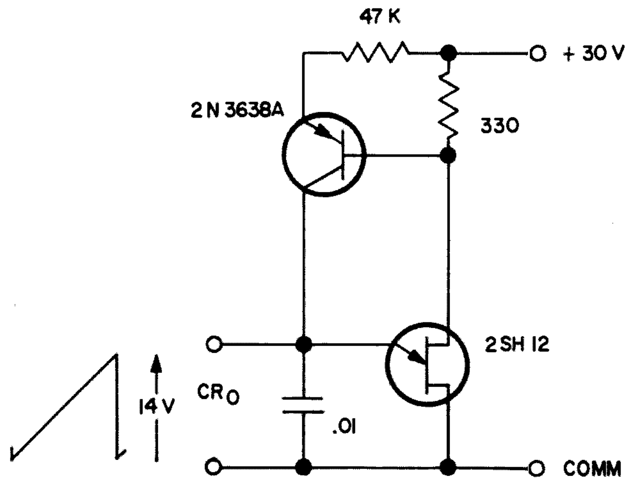

Fig. 15B. Using high output impedance to maintain a relatively constant charging current.

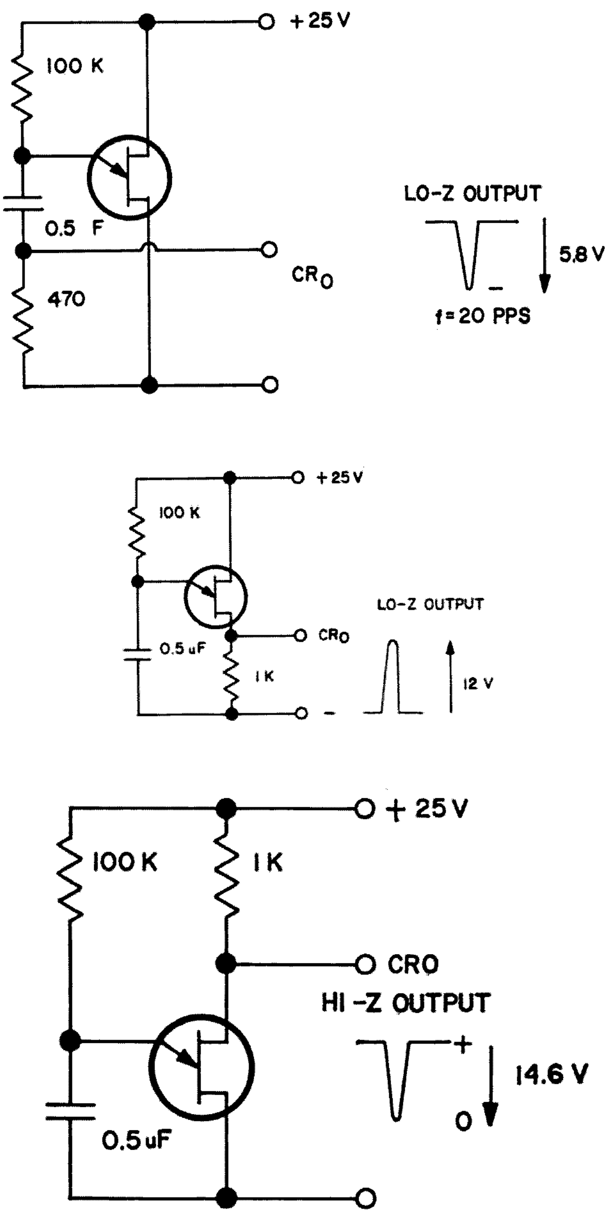

Fig. 16A., B., and C. Several circuit configurations.

Pulse generators

A current pulse will flow in the emitter, base-one, and base-two circuits each time the UJT "fires" in a relaxation oscillator. Thus, a relaxation oscillator can be used as a very efficient pulse generator giving either positive or negative output pulses at various impedance levels. Several circuit configurations are shown in **Fig. 16(a) (b)** and **(c)**.

The output pulse from these circuits has a relatively fast rise time and quite a slow fall time compared with the length of the pulse. A significant improvement in this state of affairs can be made by using an inductance in the B_1 circuit. A transistor can be used to invert the output pulse. (See **Fig. 17**).

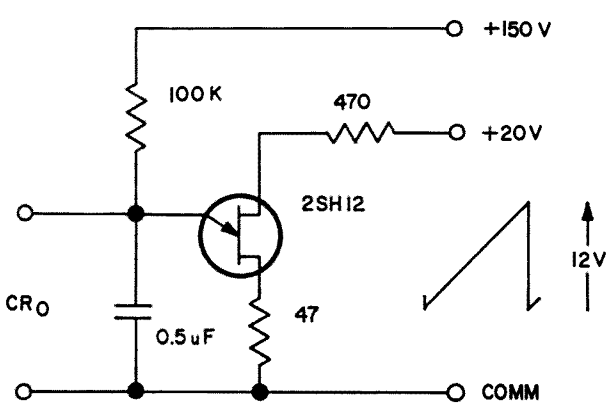

Fig. 15A. R_T returned to a higher voltage to give better linearity.

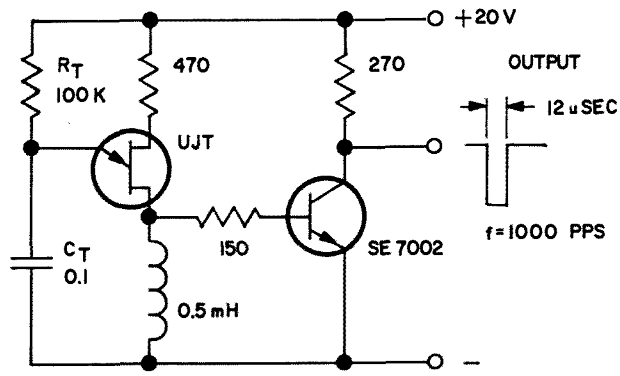

Fig. 17. Inverting the output pulse by use of a transistor.

A pulse generator can be designed by using the nomograph of **Fig. 13** and picking the circuit configuration you desire from **Fig. 16.** The resistor R_1 shown in the circuits (**a**), (**b**) and (**c**) of **Fig. 16** can be chosen by the "um-now-let-me-see-what-have-we-got" method. Juggle its value and the supply voltage to obtain the output voltage you want.

For more critical applications the circuit in **Fig. 17** can be used. The width of the pulse is determined by the inductance in the emitter (L). The frequency of the pulses (or number of pulses per second) is determined by R_T and C_T. The rise and fall times will be quite short, typically 1/20th to 1/50th of the pulse width "t".

UJT timers

A timer can be designed using the relaxation oscillator principle. Referring to **Fig. 18,** when S_1 is closed, C_T charges to the peak point voltage at which time the UJT "fires" and the capacitor C_T discharges through the relay which closes. One set of ((changeover) contacts holds the relay closed. Opening S_1 returns the circuit to its original condition. This circuit is useful for periods up to 15 or 20 seconds.

The best way to design a circuit like this is to haywire it together and juggle R_T and C_T until you achieve the desired result. I found this method reasonably fast and calibrating the pot. is easy. Note that the relay should be physically small so that it has low operating power. A huge 600 or 3000 type relay just won't work (I tried).

Have a look in the **G.E. Transistor Manual** for more timer circuits.

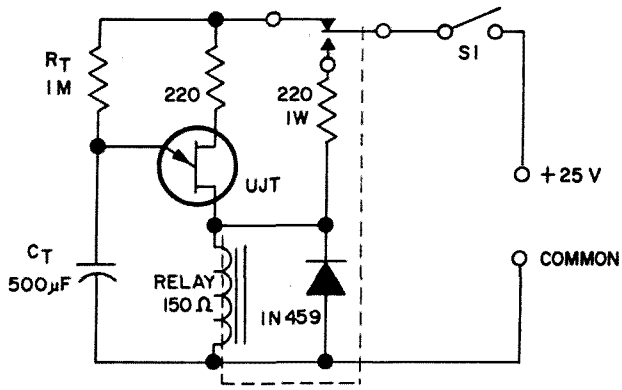

Fig. 18. The relaxation oscillator principle used for a timer circuit.

Sweep generators

Fig. 19 gives the circuit of a very handy little sweep generator. The coils can be switched if you like. It will work from about 60 kHz to about 60 MHz, depending on the transistor used for SCZ. If you don't want to go really high in frequency an OC45N will work admirably.

The circuit is fairly non-critical and some

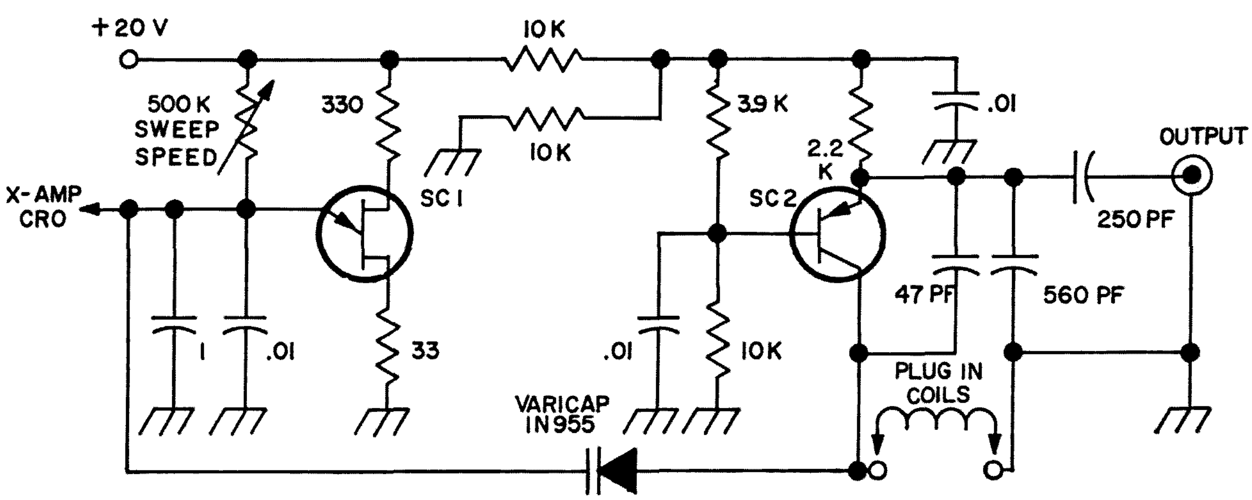

Fig. 19. The circuit of a very handy little sweep generator.

variations are permissable. The supply could be two 9V batteries in series. Coils are found by experiment. For 455 kHz the coil from an *if* transformer (with capacitor removed) is ideal. To limit the sweep range add a capacitor across the coil and retune the slug. The output is quite high and some attenuation may be necessary. Connect a high resistance in series with the output to effect a reduction.

Well, there we are. Knock up a few circuits and find out about UJT's. I think you may find a useful circuit in this article. For more ideas look up the references mentioned below.

. . . VK3ZRY

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73 Magazine Jan '66 (UJT Keyer p.12)
Dec '66 (Ipps generator p.23)
Mar '67 (sawtooth generator p.29A)

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What's Out There?

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The Universe is out there, and men go into it for short visits. Maybe one day they will live in space and we can sit down here and talk to them at distances of hundred-thousands or ten-millions of miles. Is it possible there are other intelligent beings out there already, who have never seen our sun except as a distant star?

Within recorded history people not very far removed from us believed the world extended a few miles from top to bottom, and maybe as many as several hundred from one edge to the other. They thought this little area was provided for raising people, as we might grow radishes or bugs in small dishes. The sun, moon, and stars were ornaments or maybe a part of the machinery of the Gods, but nothing more.

One Greek philosopher had a ready reply to a question of "Which is most important, the sun or the moon?" "The moon," he said. "The sun shines in the day when it is light anyway."

All through history men with new ideas have had to be careful. You could get killed that way, or at least written off as a useful member of society. Evidently you still can, if news reports are to be accepted. Yet there has been a slow trend to decreased reliance upon dogma in favor of science and technology, which really works. And just a very few years ago some scientists met (quietly) to assess the chances there might be life on other worlds.

Their question was, "Are there intelligent beings on other planets who would be interested in talking with us?" They had all of human knowledge to work with (it doubles every few years now) and while they could not come to a definite yes/no result they could estimate at least 40 and perhaps fifty million planets interested in communication, *right now*. And there could be about ten times as many worlds with intelligent life.

We'll have to make considerable progress in exploring space before we come upon grounds for a more definite opinion, or for one with a narrower margin of error. Perhaps we will discover a surprise: an explorer's camp left on the Moon. And scientists are very puzzled over some points about the two moons of Mars, which act like artificial satellites.

But the strongest chance seems to be that somehow we'll overhear a conversation or intercept a message aimed at somebody else. SWL's in space? Most probably, and radio amateurs too. Ham radio is in a doldrums now, but may be facing a greater opportunity than was open to it in the early 1900's. We'll have to enlarge our perspectives considerably to meet that challenge.

Are there worlds out there?

This is an excellent question because if there are no worlds in space other than ours we hardly need look for people living on them. A world in space without a nearby sun would be too cold to live on, and so if we want to find worlds we start by looking for stars.

What do we see if we look up at the skies late at night from some clear hill? We see a tiny bit of the universe, and several thousands of stars. I have always felt it is a splendid sight, and very thought-provoking. Except for a few wandering lights now known to be planets and some others that are specially interesting to astronomers, these stars are suns. Each one of these suns—just think! Each one *might* have a planet something like our own. If this is a possibility why haven't astronomers increased the magnification of their telescopes so we can see those stars close-up and observe any possible planets?

The uncompromising laws of nature intervene. The stars are too far away, and there is a practical limit to the magnification any optical device can achieve. There is another limit too, set by the erratic jiggly nature of our atmosphere. We cannot look to see if there are planets circling the stars.

Yet if we want to discover life on other worlds, we have to sort out the worthwhile stars from all the stars we might look at.

If we cannot see planets how do we even know they exist? Not so long ago most astronomers felt it was quite likely our own world was something of an accident, and others must be so rare it would not be worthwhile to look for them.

A simple observation finally terminated that line of thought. Our sun does not rotate very fast. Our sun has planets—we live on one of them. Is there any connection between the planets and the sun's slow rotation? Yes, and the modern theory of magnetohydrodynamics explains how the sun could have lost some of its rotation to its planets. Now we know why the planets go in the same direction the sun turns, and about the same axis.

Looking outward we discover some stars that rotate rapidly, and many that do not. Very probably the slow ones are slow because, as our sun did, they gave up that energy of rotation to their planets. Current thinking is that nearly 70% of all stars have planets, and each one may have two or three that might bear life. Our own system has three planets and a moon (ours) that might have life, and Mercury, Jupiter and Saturn are less certain prospects.

Life

Modern research into the question of how life originated is complicated, interesting, and not yet complete. We can be certain there was no life in the universe at its creation about 26 billion years ago. What happened since then to bring life into the scene? What happened here?

Well, the current trend in thinking about this question is that life appeared naturally here about 4 billion years ago. The earth was very different from the earth we know, and a number of chemical processes were going on that we can only observe in sealed experimental chambers now. The chambers have to be sealed because if we left them open bacteria and insects would enter to consume any life-like chemicals we might produce.

It turns out we do produce complex chemicals identical with those of life by simple heating and mixing processes together with electrical discharges and radiation similar to what we think were found on earth about the time life originated. Researchers are convinced this process, going on naturally for a few millions of years, would generate

a molecule that could duplicate itself. The rest of the story of life would be evolution, not creation. Could this process take place elsewhere?

Best results indicate it certainly could, and probably would. And other studies indicate that once life appears it is extremely hard to destroy. Experimenters thinking about life on other worlds have tested some of their ideas by looking for unusual kinds of life on our own world and they have found it in environments so harsh and unusual as to qualify "extraterrestrial, just happens to be here." For example, bacteria live in the cooling water of nuclear piles, an environment once regarded as absolutely lethal. Some insects found in the arctic will cook to death in the palm of a man's hand. Other insects can be dessicated—as dry as old seeds, and will live again when placed in water. Seeds thousands of years old, and some bacteria sealed in salt crystals for millions of years have come to life again in the laboratory. And some plants are known to live naturally in water at 194 degrees F., and others have survived higher tempera-

EXTREME	EARTH (life zone)	MOON	MARS	VENUS	ELSEWHERE
Temperature	—100° F To +212° F	—210° F To +212° F	—210° F To +80° F	? Very Hot	All Extremes or Lack of Them
Pressure	Vacuum To 8 Tons/in²	Vacuum on Surface	1/8 Earth Pressure	?	
Radiation	To Nuclear Pile Intensity	Moderate	Low	Low	
Life?	Yes— Everywhere	Possible Under Surface	Possible on Surface	Maybe in Atmosphere	Almost Certainly

Fig. 1. Temperature and other conditions in some known parts of space are within extremes known to be habitable here on earth.

tures than that. Lab studies have shown bacteria can thrive in jars pumped and cooled to the conditions known to exist on Mars.

Apparently, once life appears it can adapt to gradually harshening conditions fast enough to continue in the face of anything short of a cosmic disaster. If there ever was life on the moon, on Mars, Venus, or elsewhere there probably still is. Few people will be surprised if the first men visiting the moon bring back fossils, or even small plant-like things that live safely a few feet under the moon's surface.

Extraterrestrials

Once life has appeared, intelligent life is likely. The continual generation, survival and destruction of living beings wherever we see life tends to emphasize the development of the ones most able to survive. If there are many different environments there will be many kinds of beings, and the odds favor the development of intelligence sooner or later. And, once it appears, it wins over all the competion almost instantly, on a cosmic time scale. And then by degrees we have science, technology and engineering, and finally interest in other worlds.

Of all the risks involved, the interest in other worlds seems to be the greatest. It seems ten times more likely that intelligent races exist elsewhere in space than that they will be concerned about what is outside their skies. Our own history bears this out.

But if we are interested and they are there and interested too, how will we find them?

Some thinkers suggest they may have found us. I'm not referring to the flying saucer reports, which seem rather faddish to me. Some historians suggest we must have had a real visit at least once in recorded history and maybe we can find a description of it somewhere. Others suggest we already have the records but we don't understand them, and point to various odd legends of supernatural beings or visitors.

If we have had visitors from other star systems we are likely to find traces on the moon. Our moon, handy to the most interesting planet in the Solar System (from our own viewpoint at least) would offer an excellent base for observing a possibly dangerous planet (it's safe to suppose *all* planets are dangerous if they are as ours was hundreds of thousands of years ago) while simultaneously mining nuclear fuels for a re-

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters have been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

turn trip. If any traces have been left over the past few hundred-thousands of years they are probably still there. The Moon has no weather to obliterate footprints and engineering structures.

Looking a little farther out we come to Mars, interesting in itself, and its two moons. Phobos, the inner moon, behaves like a hollow shell in space and both Deimos and Phobos are in orbits unlike those of any other satellites except our artificial ones. And astronomical records suggest both moons *may* have appeared in space between our years 1862 and 1877. Several other observations about Mars are interesting, and it will probably be visited by humans next after our moon. That expedition may bring back a bundle of news!

But the most probable way we can discover any other people is by their radio communications. We have some idea how many planets might be interested in communicating with us, but what are the odds one is both interested and near enough? How near is near enough? And how will they go about it?

Right here the question becomes one of most fascinating things we can find to think about. Here we are at the sea shore, as we were once before in this same century. We can guess, we can conjecture, and while the experts are working like made on the problem there are thousands of amateurs per expert. The odds for success favor the men with two-hundred and thousand-foot reflectors and yet simply because their gear is so powerful and cumbersome they cannot try all possibilities with it. Only the best. Can ham radio jump off again, as once before, and find a place in the future

. . . W1EZT

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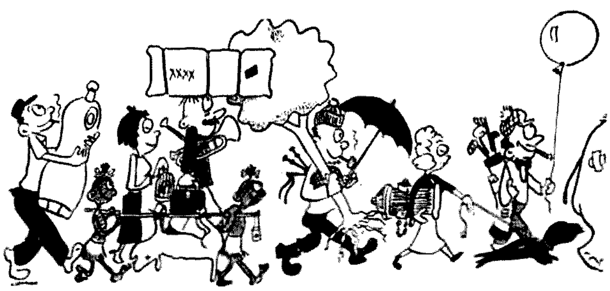

Moving? Please Let Us Know!

A New Material—VELCRO

R. Bailey, K3AQH
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Philadelphia, Pa. 19111

In this space age new things are coming along all the time, sometimes at a pace that is hard to keep up with. Some of these new ideas may be of use to hams, and a specially good one is VELCRO.

VELCRO is that stuff used on your family doctor's blood pressure cuff. If your wife does a lot of sewing, she may already know about it, and maybe there is some in her sewing box. It is a rather ordinary looking product, but when you look closely, you see it comes in two types: one with a forest of tiny nylon hooks and the other with a surface resembling felt.

When you press the two pieces together the hooks engage the felt, and if you press the attachment becomes stronger. The force necessary to separate the pieces is that required to bend one hook times the number of hooks. Since there are many hooks and the nylon is "kinda" stiff, the holding power becomes quite useful.

Applications

After thinking about this a number of ideas come to mind. For mobile operation, for instance, you can cement a piece of VELCRO to the mike and a mating piece to the dash; now the "right" spot is a general area rather than a precise mechanical point. No fumbling in traffic.

You can make up a strap of VELCRO to go around your mobile log, with some elastic or a rubber band to complete the loop. After opening your log to the correct page you slip this loop over it; the mating piece of VELCRO is located on the appropriate shelf or surface. When you put the log down there, it won't slide. Put another piece of VELCRO around the pencil and it won't dance around either!

If there is a fairly wide base area in your car, you can use some VELCRO to hold your rig in place. Three or four strips on the bottom of the rig (use low-profile bolts, rivets, or cement) against mating strips on the mounting surface will provide a surprisingly strong mounting arrangement. In the same way you can hold your rig, or parts of it, very nicely in place if you are thinking of a tilted shelf to improve panel visibility.

VELCRO will hold small, light chassis in place on top of larger, heavy ones, too. This idea has very good possibilities in view of the trend to smaller, lighter electronic components. Use noncritical pieces of VELCRO in place of harder-to-assemble (and more expensive) mechanical mounting assemblies.

When you put up your mast, wrap a piece or two of VELCRO near the top. When you are up there with test gear it can serve as a third hand holding your field strength meter or whatever.

If you are experimenting with VHF yagis, lay out a strip of VELCRO along the boom. Wrap a mating piece around the center of each element, and when you press the element down onto the boom it will stay put yet is easily moved.

Other suggestions are a bulletin board with some VELCRO for semi-permanent mounting of clip boards, pens, charts, even a small card file. Some tools might be hung on VELCRO, too, in the workshop.

. . . K3AQH

$1,000,000 TVI SUIT FILED

Grid, W4GJO, the well-known VHF pioneer, is being sued for $1,000,000 for causing TVI. His case, if lost, could mean the end to amateur radio. Please read this incredible case.

It is the purpose of this letter to set forth in as factual a manner as possible the events which have taken place in the subject TVI case.

This case was first brought to the attention of the Sarasota Amateur Radio Association in April 1968 when Mr. Ansel Gridley W4GJO requested the assistance of the TVI Committee. Mr. Gridley, who resides at 2439 Goldenrod Street, Sarasota, had received a TVI complaint from Mr. Lee H. Eggers, whose address is 2451 Goldenrod Street, next door to Mr. Gridley. Mr. Gridley explained that his neighbor had complained of interference on his TV set on two other occasions during the last ten years and each time the interference had been eliminated by the addition of high-pass filters at the TV sets. This time, however, Mr. Eggers had refused to consider the installation of a filter or to cooperate in any way. At that time Mr. Gridley wrote to Mr. Eggers to the effect that he would be happy to investigate the cause of the interference at Mr. Eggers' convenience. A copy of this letter was filed at the FCC office in Miami. As a result of Mr. Gridley's request, Mr. Larry Loper, W4WHF, of the TVI Committee contacted Mr. Eggers, who again declined to discuss the situation.

On August 1, 1968, an advertisement appeared in the Sarasota Herald Tribune. This ad was placed in the newspaper by Dixie Lee's Bar and Package Store and contained an "editorial" ostensibly written by the proprietor, Lee Eggers. The object of the editorial, of course, was Mr. Gridley.

As a matter of interest, Mr. Gridley is the owner of Tel-Appliance, Inc., one of the larger TV and stereo sales and service stores in Sarasota. As part of this operation, Mr. Gridley also handles the most complete line of amateur radio equipment and supplies on the west coast of Florida. Mr. Gridley, known as "Grid", has been a licensed amateur for over 30 years and is well known in VHF circles throughout the country.

I personally met with Mr. Eggers at his place of business on August 3 to discuss his complaint. He said that he had experienced interference in varying degrees with various TV sets and other appliances during the past 10 years. He said the interference to his new color set was unacceptable and that he would seek to prevent Mr. Gridley from operating. The possibility of a lawsuit was mentioned. Reluctantly, he consented to allow the TVI Committee to investigate the nature of the interference in his home.

On the evening of August 8, Mr. William Quigley, also of the TVI Committee, Mr. Harry Hartnup, owner of Harry's TV from whom the TV set was purchased, and myself were admitted to Mr. Eggers' home. By telephone, Mr. Gridley was asked to begin transmitting. The 28.5 MHz. band was used for the test since this has been the band most frequently used in recent months. Severe interference to both picture and sound was apparent on all channels including UHF channel 38. Several orientateons of the transmitting antenna were tried as well as power levels of 100 and 1000 watts average. The degree of interference remained substantially the same throughout the test. Single-sideband transmission was employed in all cases. It was determined that an antenna mounted pre=amplifier was being used by the TV set. When this device was disabled by disconnecting its power supply, the degree of interference was reduced significantly. This concluded the initial test at Mr. Eggers' home.

The TVI Committee also inspected the amateur station of Mr. Gridley. The transmitter in use is the Drake Model T4X followed by the Drake L-4 Linear Amplifier. A Drake Model TV-1000LP low-pass filter and a Johnson Match Box antenna coupler are used at all times. The antenna used on the 28.5 MHz. band is connected to an earth ground. To all appearances, the station is installed, maintained and operated within the norms of good engineering practice. Mr. Gridley also has several TV sets in his home. These sets are fed from an outside TV antenna and through a high-pass filter and a distribution amplifier. It was witnessed by the committee that no trace of interference occurred on these sets under any conditions of operation of the amateur station.

It was the committee's opinion at this time that the interference was principally due to

overloading of the single-transistor pre-amplifier which is loćated at the TV antenna and in a high intensity RF field. This overloading and consequent crossmodulation is producing spurious signals throughout the entire television spectrum. Under these conditions, rejection of the interfering signals within the TV set is not possible. The installation of a high-pass filter ahead of the pre-amplifier was considered but disregarded due to the weather-proofing problem. It was the recommendation of the committee, therefore, that the offending pre-amplifier, a Bonder-Tongue U-V Amp-2, be removed entirely. It was recommended that a Jerrold Model TA-66 amplifier be installed at the TV set and that a high-pass filter be installed at the amplifier input. The TA-66 is generally intended to be used as a four set coupler. It does, however, have approximately the same gain as the Blonder-Tongue amplifier, and some amount of input tuning is provided. The TA-66 operates on VHF channels only.

Mr. Eggers, his attorney, Mr. Jack Windt, and Mr. Hartnup were informed of the results of the committee's investigation and the above changes were proposed. It was also stated that the new amplifier and high-pass filter would be supplied at no expense to Mr. Eggers. The possibility of subscribing to the cable TV service which is available in the neighborhood was also discussed. It was stated that this service had been tried but that the results were unsatisfactory for reasons not related to this problem.

During the first week of September, the recommended changes were accomplished by Mr. Hartnup. Shortly thereafter, Mr. Hartnup and myself repeated the original tests at the Eggers' home. With Mr. Gridley transmitting under the same conditions as previously, there was no trace of video interference except on channel 3. Channel 3 exhibited a very slight variation in intensity on peaks of modulation. Audio interference was present on all channels, however, and to a degree approximately equal to that of our first visit. This interference was recognized as being due to audio rectification or detection in the audio amplifier stages of the TV set. The elimination of this type of interference is generally difficult and dependent upon trial and error methods. The first step would be to bypass or shield any long leads associated with the audio stages. It was proposed to Mr. Eggers that the TV set be removed to Mr. Hartnup's TV store and that the necessary work be performed. This proposal was refused. Mr. Eggers also stated that he was not satisfied with the quality of the reception with the new amplifier and that he wanted it removed and his original pre-amplifier re-installed.

It should be mentioned that Mr. Eggers is an avid television viewer and expects to receive signals reliably from stations other than the principal stations in the area. These principal stations are WTVT-TV, channel 13, and WFLA-TV, channel 8, both in the Tampa-St. Petersburg area, a distance of about 50 miles over flat terrain. The other stations which he expects to receive include several lower power stations in the Tampa-St. Petersburg area, one in Ft. Myers, a distance of 65 miles, and one in Orlando, over 100 miles away. Even in the case of the principal stations, Sarasota is considered to be a fringe area.

Also during the month of September, Mr. Hartnup contacted the RCA factory in an effort to obtain their assistance on this problem. Their suggestions were essentially the same as those of the TVI Committee. As a matter of interest, the set uses the RCA CTC 30 color chassis.

During the latter part of September, Mr. Eggers and Mr. Gridley were advised that on October 2, 1968, Electronics Technicians Robert Ritchie and William McCrimmon of the Tampa FCC office would arrive in Sarasota to investigate the complaint. This investigation was apparently the result of a letter written by Mr. Eggers' attorney to the FCC. Upon their arrival, Mr. McCrimmon inspected Mr. Gridley's station. He also observed the absence of interference to a TV set just a few feet from the transmitter. After approximately an hour and a half, Mr. Ritchie entered. He said that he had visited every house within two blocks of the Gridley residence, and that while a few isolated cases of interference were reported to him, in every case Mr. Gridley had quickly provided the necessary filters. Mr. Ritchie stated that "Mr. Gridley's cooperation in this matter appears to be outstanding". Tests were then conducted with the FCC inspectors observing Mr. Eggers' interference. Finally, a test was made with the FCC inspectors monitoring a TV set in their automobile located approximately 75 feet from Mr. Gridley's beam. With Mr. Gridley operating with the maximum legal power, there was no evidence whatsoever of interference on any channel. Upon leaving, Mr. Ritchie said that he could not make an official recommendation at that time and that

(More TVI suit on page 89)

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Nikola Tesla
Master of Electrical Energy

"Give me a lever long enough, and a fulcrum on which to rest it," Archimedes said, "and I will move the Earth." Nikola Tesla, a nearly forgotten man from a forgotten country, who was perhaps the greatest scientific genius in human history, needed no such prerequisites as Archimedes. Tesla succeeded in resonating the globe as though it were only a child's toy.

This man, who dared presume his power as significant as a God's, had humble beginnings. As the night of July 9, 1856 was drawing to its end, Nikola was born, the second son of a Serbian Orthodox clergyman in Smiljan, Lika, Croatia. (Croatia is now one of the six republics of Jugoslavia.) Djouka Tesla, Nikola's mother, was unable to read or write, yet had an excellent memory and literary facility. She could recite long passages from the Bible and thousands of verses of Serbian national poetry and was an accomplished seamstress. Nikola's father, Milutin, had had an excellent education, though, and had started a career in the military, only to enter the ministry shortly after he married.

Tesla forebears had given a long line of sons either to the military or the Church and Tesla's father intended Nikola to become a minister. The elder son, Dane, had a brilliant mind and the family expected him to bring them honor as a scientist or engineer. But Dane died when he was twelve years old, as the result of an accidental fall. It has been speculated by some writers that Nikola had to succeed in his brother's stead, perhaps because he felt guilty. This author thinks rather that Tesla's choice of vocation was the inevitable result of natural ability.

Young Nikola had an inherent mechanical aptitude which evidenced itself many times in his early years. When he was only four years old, he built a water wheel for the creek which flowed near his home. During his childhood he made many curious devices. One such was a popgun which fired a ball of wet hemp. He built and sold these to his fellow children until a rash of broken windows ended this enterprise. He turned to archery and went from bow-and-arrow to crossbow and then arbalest. He was fascinated by the idea of flying and when he was twelve years old, made an unsuccessful parachute jump from the barn using an umbrella.

He evidenced an original turn of mind from his earliest days. Once he noticed that after lightning struck from the dark masses of clouds that torrents of rain would fall, and decided that one might be able to control rainfall by controlling the lightning. Years later he had succeeded in producing artificial lightning, but was never able to convince the U.S. Patent Office that weather control might be possible.

In school his talents quickly led him to the head of his class, particularly in mathematics, a subject he favored. He detested resorting to paper and pen when it was so easy for him to solve any problem in his mind almost as quickly as the teacher had given it. This ability led to his being suspected of cheating and he was not given a passing mark. Nikola went to the director of the school and demanded an examination. The test was duly given and in the presence of the director and the teacher, Tesla solved problems far beyond his years. Suspecting that he had somehow gotten the answers to the standard examination, the officials departed from it to throw even more difficult problems at him, which he solved equally well. The astonished men could only acknowledge that Nikola Tesla possessed an astounding ability and passed him.

At fifteen Tesla continued his education at the Higher Real Gymnasium in Karlovac, Croatia, which corresponds to our college

level training. He completed the four year course in three years. During this time, he was living with an aunt and her retired army officer husband. The woman felt that Nikola was of delicate health and that heavy meals would have a bad effect on him. Tesla remembered this as the hungriest period of his life. While he was at Karlovac, he took many hikes along snow covered mountain trails. One day, he began rolling snowballs down a slope, trying to see how big he could get one. He succeeded too well and sparked an avalanche which roared down the mountainside and diverted itself harmlessly in a field, only just missing some farm buildings. Tesla was horrified at the near disaster he had created but wise enough to recognize that the tremendous power of Nature could be harnessed by relatively small applications of Man's power.

When he had completed his studies at the Gymnasium, his father had written urging him to take a hunting trip rather than return home. Tesla impulsively disregarded his father's advice and went home to find the area in the grip of a cholera epidemic. Worse than this was the elder Tesla's desire to see his son study for the ministry. Milutin Tesla was not wholly autocratic, however. He knew that if his son did not enter the church, he would be required to serve three years in the army. Nikola felt he was caught between Scylla and Charybdis, about to be crushed by alternatives he could not stand. Three years as a soldier seemed to him three years as an unthinking robot, compelled to the mindless disciplines of drill and routine. And a life in the ministry would leave him no time to learn Nature's secrets. Nikola had decided that he wanted to be an engineer.

The three years of undernourishment and the spiritual anguish he faced now so weakened him that he succumbed to cholera. For months he lay ill, one sinking spell leading to another. The family doctor finally announced that he could do nothing more for the boy and the family should prepare themselves for his imminent death.

Now the elder Tesla was facing his own crisis. One son had already died. He had pledged Nikola to the church, but if the boy died, the pledge would be unfulfilled. In anguish the father asked the dying son what he could do. Nikola whispered that he could get well if only he could study engineering and the despairing father quickly agreed. The deathbed crisis passed, Nikola's will strengthened and he began to recover. Tesla wrote in later years that no magical event had taken place, but rather his recovery had been because of a distasteful but potent medicine his mother prepared.

Subsequently the army declared the convalescing Nikola unfit for service and he was now free to pursue his goals. The elder Tesla's influence with other members of the family in the military for this decision has been suggested but is not definitely known. It is a fact that the father sent Nikola away for a year while the decision was being rendered. During this year Nikola amused himself with such fanciful projects as a proposed subterranean tunnel between Europe and America through which containers could be propelled by water pressure. Tesla quickly realized that drag would make the project unworkable, but nevertheless enjoyed such pursuits as a stimulus to his imagination.

In 1875, nineteen-year-old Tesla entered the Polytechnic Institute at Graz, Austria. In his effort to prove himself worthy of his father's reconsidered decision, he took twice the normal number of subjects and limited himself to less than four hours' sleep a night. At the end of the year, he returned home with the highest possible marks, fully expecting his father's praise. Instead his father disregarded the effort his son had made and criticized him for endangering his health. It was only years later that Tesla discovered that the dean of the technical faculty had written Milutin Tesla to say that Nikola was "a star of the first rank but will kill himself from overwork."

In his second year at the Institute, Tesla limited his studies to physics, mechanics and mathematics. During a demonstration of a Gramme motor/dynamo, Tesla remarked that the commutator sparking indicated power loss. His instructor, Professor Poeschl, patiently explained that the commutator was necessary to provide a direct current output. Tesla responded that by discarding the inefficient commutator and using the natural alternating current from the rotating armature, far greater efficiency could be attained. A hail of invectives greeted Tesla's conjectures, comparing them with such foolishness as perpetual motion machines. Since early experimental motors would not run,

it was assumed that the positive and negative cycles were cancelling one another. Some ac generators were used about this time, but only for resistive loads, such as street lamps. Everyone knew you could never get a motor to work on ac!

Though Tesla bowed before the authority of his professor, he could not get the concept out of his mind. Plan after plan was imagined and discarded. Tesla had had, for his earliest childhood memory, an amazing ability to visualize objects. When he thought of something it appeared before him, as real to him as any object in the external world. It took some time for the child to realize that other persons could not perceive these visualizations of his. The adult Tesla always said that he perfected his models in his mind, and that there they were so real that he could see signs of wear, and in the case of rotating machinery, could actually tell whether or not it might be out of balance. His visualizations were accurate to the thousandth of an inch; the piece parts he required did not need any trial-and-error machining. Years later, in America, the staff he had in his laboratory had a hard time keeping up with him. If his precise verbal instructions did not seem clear to a workman, Tesla would make a small, neat sketch on the handiest piece of paper. It is said that no matter what size paper Tesla picked up, his sketch was sure to be no more than one inch across, yet perfectly detailed.

This uncanny visualization, coupled with his amazing mathematical ability, certainly aided his inventive efficacy. Tesla had what we would call a photographic memory, and was able to quote—from beginning to end—Goethe's *Faust,* as well as a good deal of Shakespeare, and other classics. He committed the logarithm tables to memory, so that he would not have to waste computation time in reference.

Since he had heeded his father's advice for his second year at the Polytechnic Institute and had not taken as many classes, he rounded out his activities with billiards, chess—and poker. As he could visualize many moves ahead on the chessboard, it was only a short time before he had conquered all his fellow students. He then set about organizing a chess team which challenged other schools—the first known example of intercollegiate activities. His first poker game was a memorable one—the companion who took him to the game had promised a lamb for the shearing. By the end of the evening, the lamb had won everything. Then he amazed everyone by returning, to the cent, what each player had lost. For Tesla it was only a means of relaxation, not a profit-making venture. Many times he returned to the card table, and it was the same. Then one night luck or his own ability let him down. He calmly bet the tuition money he had received for the next year's study, and it was quickly gone. The game was over—but no one offered to return the money as Tesla had. This was a painful lesson about the nature of men and Tesla was deeply shamed that he had lost his parent's careful savings. Yet he could do only one honorable thing, and that was to confess all. He returned home, found his mother, and told her what had happened. Djouka Tesla sagely understood. Where his father would have scolded him for immoral activities, the mother knew that her son was obsessed. She gave him what little remained of their savings, telling him that he had yet to learn a lesson. When Tesla returned to the card sharps, they expected only more loot. Instead, Tesla, playing with steel determination, won everything. When the game was finished the players expected their money to be returned. This time, Tesla kept it. He had regained his tuition, and the money his mother had advanced him was returned. He made a solemn oath never to play cards again.

When he had completed his studies at the Institute, Tesla took a job at nearby Maribor with a tool-and-die works which was manufacturing electrical equipment. The money he saved enabled him to study a year at the University of Prague. Upon graduation, he travelled to Budapest, where a telephone central office was being built. The excellently-educated engineering graduate found that no responsible engineering position was open to him. Ironically, the job he was able to accept was that of draftsman with the Hungarian Government Telegraph Office. Some forty years later, he wrote that it was "at a salary which I deem it my privilege not to disclose!" He also recalled that, "By an irony of fate my first employment was as a draughtsman. I hated drawing; it was for me the very worst of annoyances." Yet Nikola Tesla could not do a job poorly and it was not long before his

ability was noticed and he was promoted to more responsible work and finally made chief electrician to the telephone company. At only twenty-five years of age, he found himself engineer-in-charge of an entire system.

It was to his liking. He found himself fully occupied during the day, limiting himself to a five-hour rest period, in which he tried to keep up with current technical journals, sleeping only two hours a night. At this time he invented the first "speakerphone", a loudspeaker apparatus with which a roomful of people could hear a telephone conversation. Tesla never bothered to patent it, though the company put it into service. Thirty years later, he remarked that it compared favorably with then-current loudspeaker designs.

All the while, his mind was constantly working on the concept of alternating current, but he had not yet solved the basic problem. Then the long hours of toil, welcome though they were to him, took effect and Tesla had a breakdown. Chief symptom of the unique nervous disorder he developed was a highly abnormal sensitivity. Tesla wrote: "I could hear the ticking of a watch with three rooms between me and the timepiece. A fly alighting on a table in the room would cause a dull thud in my ear . . . In the dark I had the sense of a bat and could detect the presence of an object twelve feet away by a peculiar creepy sensation on the forehead." Doctors pronounced the malady incurable, though they did not know what it was. As quickly as it had come, it went. While he was convalescing, his assistant, Szigeti, went with him for a walk in the park one afternoon. Tesla was pleased that the illness had not affected his memory and, looking at the sunset, began an appropriate quote from Goethe. Suddenly, before him, was the alternating-current apparatus he had thought about for so long. "Watch me reverse it!" he cried, throwing an imaginary switch. Szigeti feared that his boss had gone 'round the bend. Tesla calmed himself enough to explain. Evidently his mind had unconsciously completed the assigned task while he was ill. Tesla picked up a stick and sketched the circuit diagrams on the dirt path, explaining each detail to Szigeti. Tesla would use a two-phase ac in the field coils of his motor, which would produce a rotating magnetic field. This magnetic whirlwind would—by induction—pull the armature around with it. The armature would have wound coils closed on themselves, requiring no external electrical connection. Thus, in a blinding flash of inspiration, Tesla had grasped the answer. There would be no commutator to cause power loss; the only wear point of the motor would be the mechanical bearings.

Years later, a president of the American Institute of Electrical Engineering said: "The work of Nikola Tesla in his great conception of his rotary field seems to me one of the greatest feats of imagination which has ever been attained by the human mind."

The rotary magnetic field was more than an invention. It was a basic discovery, and it was this ability to perceive new insights into nature's wonders that set Tesla apart from other men. While those such as Edison made improvements on existing theory, Tesla forged ahead into an uncharted wilderness, where Man had not gone before. It was Tesla's gift that he could discover—but the gift contained tragedy, in that other men could not, or would not follow.

It was in February, 1882, that Tesla grasped the answer to the alternating-current problem. It would be six years before he would convince men that this was a revolutionary, wonderful new system. His immediate problem was more mundane—the job he had held was ended, as his employer had sold the business. Puskas, the employer, wrote a letter of recommendation for Tesla, which enabled him to get a job with the Continental Edison Company in Paris.

Tesla felt that the cosmopolitan city of Paris would give him the opportunity he needed and he swiftly took the job. Even more swiftly, he found that his employers were not interested in any "crack-brained schemes". Tesla tried to interest businessmen in his alternating-current system. Friends warned him that someone would steal his discovery, but that was hardly the case. Tesla could not even give it away.

In the meantime, his position with Con. Edison had been done in the usual flawless manner. Tesla was assigned as a roving trouble-shooter, and in 1883 was sent to Strasbourg, Alsace, then part of Germany, to straighten out an embarrassing situation. A new power plant had been built and Emperor William I was present at the dedication ceremonies. Unfortunately, the plant

had been wired by men who were less than adept at their job and when the master switch was thrown to activate the new lighting system, a short circuit blew out one wall, showering bricks and debris on the dignitaries. The Germans understandably would not accept the plant in its present condition and Tesla was dispatched to the rescue.

He soon put matters right, even in the face of German bureaucratic bungling. He writes of the "efficiency" of a simple matter of placing a hall light, in which the whole chain of command had to be consulted before the light could be installed at the very spot Tesla had suggested to begin with. When he was not taking time in matters of this sort, however, he was free to work on his own. He had brought some materials with him, and rented the facilities of a machine shop near the railroad station for evening work. There he built his first induction motor. Because he could vis*u*alize the final design so accurately, he did not need blueprints. He was a fussy worker, however, and the precise machining and polishing of the parts took time. The individual parts did not need cut-and-fit partial assembly but went together into a finished product the first time.

It was a dramatic moment. Tesla had thought the idea through in his mind, but it was new, it had never been tried before. Perhaps he had deluded himself, maybe it was only wishful thinking. He could only find out one way—he threw the switch. The motor hummed, the armature turned. Almost instantly, it had built up full speed. Tesla threw the reversing switch. The armature stopped, began to revolve in the opposite direction. It was clearly a success.

Tesla had made many friends in Strasbourg, impressed many people because of his efficiency and knowledge. Now he went to the mayor and various businessmen. Perhaps the sight of a working model would suffice where words had failed. But it was the same. No one seemed interested in what was the most significant commercial development in electrical engineering.

The despairing inventor returned to Paris, where another disappointment awaited him. He had been promised a substantial bonus on successful completion of the Strasbourg project. He had delivered. Now the managers of the works sent him on a wild-goose chase. The treasurer would pay him, only the treasurer said he did not have the authority to issue a draft; the operations manager understood, but he had not authorized the trip, etc., etc. Tesla gave his resignation in disgust.

Charles Batchellor, one of the company administrators who had been friendly toward Tesla advised him that he would have a better chance of achieving success in America. Batchellor was a close personal friend of Thomas Edison and gave Tesla a letter of introduction.

Once the idea was in Tesla's mind, it didn't take long for him to settle his affairs. He sold his possessions and books and bought a steamship ticket. On the way to the station where he would catch a train for the seaport, he was robbed. He managed to get to the docks but the steamship officials would not let him board without a ticket. He persuaded them that if no one showed up before departure to claim the reservation that they should accept his story as true. He arrived in America with four cents in his pockets, a book of his own poems, a couple of technical articles, some notes on a mathematical problem and on the design of a flying machine—and a wealth of inventive genius in his mind.

He presented himself to electrical wizard Edison quickly and angered the great man immediately by telling him of his alternating-current system. Yet Edison was quick to recognize the ability of the young immigrant and impressed by the letter Batchellor had written. Never one to ignore the knock of opportunity, Edison hired the well-educated and experienced engineer for eighteen dollars a week—hardly more than he paid the average mechanic in the shops.

Tesla was impressed on their initial meeting by Edison's forceful personality and recognized that the practical man had done quite a lot with no formal training. He wondered if his own educational process had been a waste of time. He was quick to learn, however, that it had not. Edison firmly believed in the trial-and-error approach to all things and much later Tesla wrote that "a little theory and calculation would have saved him ninety percent of his labour."

Tesla was initially assigned minor routine work but when he showed his talent and his dedication by working eighteen hours

a day, Edison soon trusted him with important tasks. One of the most significant concerned the steamship *Oregon*. Edison generating equipment had been installed on this most up-to-date liner of the day and worked well for many months but eventually broke down. Edison sent his lesser lieutenants to make repairs but they failed. The *Oregon* did not sail as scheduled and Edison was faced with financial and personal embarassment because of his equipment. In desperation he sent hardworking Tesla to try his luck. Working throughout one night with the assistance of a willing crew, Tesla rewound the armatures which had short-circuited. Leaving the ship in the early morning, Tesla met Edison and Batchellor, who had returned from Paris. When Tesla reported success, Edison remarked to Batchellor that Tesla was good as Batchellor had said, and "indeed, he's even as good as he thinks he is!"

But their good relationship was soon at an end. Tesla was already discomfitted by Edison's refusal to consider an alternating-current plan. It is true that Edison had made a $2 million investment in New York City on a dc distribution system. Naturally he did not want to see this expenditure threatened.

The final blow came as the result of a statement Edison made to Tesla concerning some research problems. Edison told him it would be worth fifty thousand dollars if he could come up with the answers. In all, Tesla's improvements led to twenty-four new dynamo designs utilizing highly efficient short field-core magnets, some new automatic controllers, and several patents taken out in Edison's name. Tesla had delivered the goods and eagerly awaited the promised bonus. When it was not forthcoming, he asked the great man and was told: "Tesla, you just don't understand our Yankee humor."

It was Spring, 1885, and he had been with Edison less than a year, but he could no longer go on. As Con. Edison had cheated him in Europe, so he was led down the garden path in America by Edison himself. Tesla's reputation had developed well, and some promoters approached him with the idea of starting a street and factory lighting company under his name. Tesla offered his alternating current system to them, but they rejected it in favor of quick profits in this utility venture. Tesla agreed to develop a practical arc lamp for shares in the company. For about a year he worked at a very small salary, producing all the equipment the businessmen had asked for, and taking out several patents. When the system was well under way, Tesla was given stock shares and was quickly manipulated out of the company. He found that his share certificate was worth very little. The United States was undergoing a depression and Tesla was without income. His former associates, not content with having eased him out of the company, new made spurious claims about his unreliability. And Edison certainly had nothing good to say about him.

Tesla underwent such a period of hardship during the next year that he would never discuss it in later life. It is known that he did occasional electrical repair jobs, when he could find them, and that he worked as a common laborer. During the winter of 1887, Tesla was working as a ditch digger. The crew foreman, a former stock broker who had lost everything in the market, became interested enough in Tesla's theories to introduce him to A. K. Brown of Western Union Telegraph. Brown and an associate financed a laboratory for Tesla, and organized the Tesla Electric Company in April, 1887. Tesla's lab was at 33-35 old South Fifth Avenue (later West Broadway) and not far from the Edison works. The models Tesla now built were identical to the designs he had conceived five years before. In all this time he had made no notes—the concepts were firmly locked in his memory. By October of that year, Tesla had filed for a patent. He wanted a single patent for the discrete elements which comprised his system. The U.S. Patent Office was horrified at the idea of such a sweeping omnibus approach. They insisted on a breakdown to seven separate sections. By the end of the year he had filed for and received thirty basic patents.

The scientific world which had ignored Tesla for so long now could not contain its amazement. As the import of his system was grasped, he was praised as the scientific genius of the age. The lecture he delivered on invitation to the American Institute of Electrical Engineers on May 16, 1888, is a classic of the electrical engineering field. The theory and practise he presented are the basis of the system we still use today.

In one stroke he accomplished an engineering breakthrough of such magnitude that no comparable development has been presented since. Tesla was on the crest of an inventive wave that would last for thirty years.

Fortunately for Tesla—and for the world—the man of commerce who could bring this scientific feat out of the laboratory and into the everyday world of engineering practise approached. This was George Westinghouse, inventor in his own right, and head of his own company. Westinghouse was not committed to direct current as Edison was. In Tesla's system, he saw the revolutionary means of long-distance power transmission that would reap profits such as Edison's plant could only wish for. Westinghouse offered Tesla one million dollars for the rights to the group of patents, which now numbered forty. Tesla agreed, provided that a royalty based on equipment produced was also paid. A conservative estimate was later made that Tesla should have received an additional $12 million in royalty payments.

This dynamic duo was the worst possible threat to the Edison system. What Tesla—the man of vision—lacked in financial awareness, Westinghouse—the successful entrepreneur—could supply. The United States was leaving a phase of depression and entering one of explosive capitalistic growth, in which giant industrial empires were born. Westinghouse, in his eagerness to make the most of the Tesla system, expanded his corporation by consolidating a number of smaller companies and also by attracting much outside capital. The time came, however, when Westinghouse's board of directors overrulled him on the matter of royalty payments to Tesla. Even though there was a legal contract in which the payments were stipulated, the board argued to an unwilling Westinghouse that such payment would seriously endanger the stability of the corporation. Further, if Westinghouse insisted on honoring the contract, much of the outside capital would be withdrawn. As an inventor himself, Westinghouse understood the justice of the royalty payment; as a businessman, he could not bear the thought of the empire crumbling. He went to Tesla and explained the situation. Tesla had become a close personal friend of Westinghouse and understood the problem. Further, he was more interested in seeing his system operating on a successful basis than in collecting a payment legally his, which would wreck any chance of that system's development. Tesla tore up the contract and the Westinghouse empire was saved.

Tesla had had to give half of his million dollar initial payment to Brown and his associate, but the half which was left served well enough to maintain the most splendid research establishment seen in America at that time. Tesla embarked on a program of research that would have broken most men. He began his monumental studies into high-frequency phenomena, and at most fortunate time.

The Edison faction had not been inactive during this period and in a calculated campaign to destroy the alternating-current disciples, began a whirlwind of adverse publicity. Edison and his friends gave Sunday afternoon demonstrations on the evils of ac by electrocuting cats and dogs for the edification of visitors.

Edison wrote: "Just as certain as death Westinghouse will kill a customer within 6 months after he puts in a system of any size. He has got a new thing and it will require a great deal of experimenting to get it working practically. It will never be free from danger."

A propaganda campaign of immense proportions arose. Most of the so-called scientific proof of the horrible dangers of ac erupted from Edison's laboratory in West Orange. Misleading statements were issued to the press. Pamphlets were distributed, warning the people that it would soon be a matter of taking one's life in his hands to merely walk the streets, constantly at the mercy of the lethal high-tension wires. A further suspicious fact is that a former laborartory assistant at West Orange, H. P. Brown, began lobbying and lecturing for the passage of a bill in the New York state legislature for the provision of death by electrocution.

Such a bill was passed in 1888 and H. P. Brown, now a consultant to the state, authorized the purchase of three Westinghouse alternators to be installed at Sing Sing Prison. George Westinghouse protested this particular use of his equipment, but the authorities pointed out blandly that dc generators could hardly provide the high voltages necessary. On August 6, 1890, con-

victed murdered William Kemmler was to be put to death in a secret ceremony. The engineers who had installed the electric chair had been perhaps more frightened of it than was necessary. It was reported that the power was insufficient to cause death. Repairs had to be made and the execution repeated, resulting in "an awful spectacle, much worse than hanging . . ."

Meanwhile, Tesla had not been idle. He had, of course, selected 60-Hertz operation as best for commercial power applications. Indeed, he had opposition from Westinghouse engineers at the Pittsburgh plant where the new apparatus was being developed. They preferred a 133-Hertz system, partly because of decreased cost of core materials needed at the higher frequency. Tesla left in disgust, even though Westinghouse was able to offer him $24,000 a year salary. Shortly thereafter, the engineers did select our familiar 60-Hertz system as the standard. Tesla remarked that the year he spent in Pittsburg was wasted in minor design problems and that he was not free for creative work. In the next four years, he was granted 45 additional patents on polyphase current distribution.

His researches into higher frequencies had led him to the discovery that as the frequency increased, less and less iron was necessary in transformer cores. Utilizing conventional rotary dynamo technique, he built devices which produced up to 10,000 Hertz. The next step was the production of even higher frequencies and the development by him of the air-core high-frequency transformer known and loved by all as "the Tesla coil". Two decades later, F. W. Alexanderson was developing high-frequency ac dynamos for high-power wireless transmitters for the government along the same lines.

Incidentally, Tesla's choice of 60-Hertz operation made possible cheap electric clocks, driven by synchronous motors, a fact he pointed out freely.

Along with the high frequencies Tesla was now producing, were also high potentials, so much so that conventional insulating methods were ineffectual. It was at this time that Tesla produced the technique of oil immersion, which had great commercial importance. He had soon reached the practical limits of frequency from rotary dynamos. Now he was exploring the field of resonance phenomena. He developed the technique of electrical tuning in 1890, one of the basic principles of radio.

Utilizing Lord Kelvin's theory of the damped oscillation wave of a discharging condenser, Tesla developed means of charging a condenser by low voltage, then using the "disruptive discharge" through the primary of his air-core transformer, deriving very high-frequency oscillations and extremely high potentials in the output. He discovered the heating effect in the human body of the high frequency currents and thereby laid the principles for medical diathermy. Here was another pioneer discovery for which he took no patents nor credit.

He lectured once more before the American Institute of Electrical Engineers in May 20, 1891, on the subject of high frequency currents, and demonstrated a variety of phenomena. With apparatus then, he was able to achieve a spark discharge of over five inches, indicative of a potential in excess of 100,000 volts. The induction coil he used was energized from a generator of his own design working at 20,000 Hertz. He described the various discharge phenomena exhibited under varying conditions of potential and frequency. In his research he had discovered that the nerves of the human body could not react to currents higher than 700 Hertz. He recognized that high voltage as such was not lethal, as he had taken the high-frequency discharges of his larger apparatus many times without ill effect. Partly it is because of "skin effect", in which the high frequency tends to travel across a surface of a conductor. Also the output of Tesla's apparatus had a low current density. He wrote that slight changes of potential, current, and frequency could work together to form a lethal shock.

He said that the surest way to electrocute a person was to subject him to sustained direct current, but that the most painful means of killing would be to use a low-frequency alternating current. It is conceivable that a high-power, high-frequency current could kill swiftly and painlessly. But his demonstrations before the Institute were clear proof that alternating currents, as such, were quite harmless. Tesla repeatedly put himself into the high voltage secondary circuit of his coil, in the process of lighting bulbs of his own design, with no discomfort.

Part of the awe-inspiring show was the fact that the forms of illumination Tesla was demonstrating had never been seen before. Instead of the ordinary Edison bulb for light, Tesla was using ordinary wires in normal atmospheric pressure to demonstrate luminosity effects. He had vacuum lamps, lamps with other gases, lamps with extremely high internal pressure—and most of the above had but one terminal. Others had none at all!

The production of a practical means of commercial power and now the development of a whole new spectrum of alternating currents—both within three years—established his reputation firmly with the scientific community. All at once he had more offers for lectures, after-dinner speeches, demonstrations and consultations than he could cope with. One of the problems was that his high sense of intellectual honesty and originality required him never to duplicate the material in a lecture; thus each appearance of this prodigal genius before the public was a unique event.

He was invited to lecture before scientific bodies in England and on the Continent. In February, 1892, he gave another lecture on high-frequency currents before the Institute of Electrical Engineers in London. Sir James Dewar asked Tesla to repeat the lecture before the Royal Society. Tesla had other plans and demurred, but Sir James took him to Michael Faraday's chair and plied him with the remaining private stock of whisky which had belonged to that earlier genius of electrical invention. After such a singular honor, Tesla could do no less than agree.

While he was touring Europe he received word that his mother was gravely ill. He arrived at her home in time and was able to talk with her that day. She died during the night. The strain of rushing to her deathbed caused a patch of hair on his head to turn white overnight, but a month later it had regained its natural color. His father had died years before, while he was still a student.

When Tesla returned to America he realized that his social success had cut into his research time tremendously and he turned away from all such engagements in the future, preferring to devote himself to useful work in the laboratory. During this period he experimented with such diverse items as high-frequency currents, mechanical oscillators, X-rays, and astronomical studies. He prepared a large exhibit for the 1893 Columbian Exposition, where Westinghouse had won the contract to furnish power and lighting equipment. During frequent demonstrations at this World's Fair, Tesla passed one million volts of high-frequency electricity through his body, to turn copper plates molten or to light special bulbs of his own exotic design. The public was thoroughly convinced that ac was not the danger Edison and his followers claimed.

The final blow the dc faction received was the harnessing of Niagara Falls. The child Tesla, having seen a picture of Niagara and perhaps influenced by that first toy waterwheel, prophesied that he would someday make the falls work for him. Now that dream was to come true. A charter for developing power at the Falls had been granted in 1886 and in 1890 Edward Dean Adams, head of the Cataract Construction Company, organized the International Niagara Commission. Lord Kelvin, the famous British scientist, was made chairman of this body, which was to determine the best method. A prize of $3,000 was offered for the best plan submitted. Tesla was frantic to toss his hat in the ring but George Westinghouse pointed out that the prize would be insufficient payment for value received and persuaded Tesla to persevere. A further complication was that Kelvin favored direct current. However, in 1893, when none of the major manufacturing concerns had submitted plans to claim the prize, the commission asked for bids. By now the Edison faction had capitulated and paid for the rights to utilize the ac patents. Westinghouse's bid for the generating plant was accepted on May 6 and the by-now General Electric Company, Edison's empire, was chosen to build the transmission line to Buffalo, twenty-two miles away. After the completion of this project, which was described as the "most tremendous event in all engineering history," Kelvin admitted that alternating current had many more advantages, and further stated that "Tesla has contributed more to electrical science than any man up to his time."

Ironically, during this period of commercial development of the polyphase ac system, Tesla was referred to as an imitator by the British press, which claimed that he

had used as the basis of his system the apparatus of a physicist at the University of Turin, Professor Galileo Ferraris. It has been proven that Ferraris first presented a paper on "electrodynamic rotation" in 1888, six years after Tesla's discovery of the rotating magnetic field, and indeed, several months after Tesla's application to the U.S. Patent Office. Ferraris had developed an alternating-current device as a demonstration of circularly polarized light and stated specifically that the principle behind his model could never be developed as a practical power unit. Yet chauvinistic English publications, which had received notice of the Tesla system, ignored it.

In 1891, another pretender to the throne arose, in the person of Dolivo Dobrowolsky, at the Frankfurt Industrial Exposition of 1891. Dobrowolsky claimed the invention of the first practical ac motors, and later reduced his assertions to a greater efficiency of his three-phase motor than that of the original two-phase Tesla induction motor. However, the chief engineer of the project, C. E. L. Brown, completely smashed Dobrowolsky's claims by writing to the *Electrical World* that "the three-phase current as applied at Frankfurt is due to the labors of Mr. Tesla and will be found clearly specified in his patents."

Part of the problem during this period of massive technological change was that the lines of communication and publication of new inventions were very slow. And there were those that put forth fradulent claims, so that they could reap the rewards. But at the same time, errors of fact have been made by writers too lazy to do proper research.

Finally and unequivocally, Tesla was granted the credit due him, by scientists, engineers, and editors throughout the world. It is certain that the many persons who saw Tesla's demonstrations at the Columbian Exposition would not soon forget him. By 1900 there were many usurpers and infringers on the Tesla patents. The Westinghouse Co. took about twenty suits to the courts and the Tesla patents were upheld in every case. Judge Townsend of the U.S. Circuit Court of Connecticut in September, 1900, wrote: "It remained to the genius of Tesla to capture the unruly, unrestrained and hitherto opposing elements in the field of nature and art and to harness them to draw the machines of men . . . he first conceived the idea that alternations might be transformed into power-producing rotations, a whirling field of force.

"What others looked upon as only invincible barriers, impassable currents and contradictory forces he seized, and by harmonizing their directions utilized in practical motors in distant cities the power of Niagara."

After his European and American lecture tours and his triumph at the World's Fair, Tesla withdrew from public and social life. The next two years were full to bursting. Induction coils had led him from the curious phenomena of high-frequency to the realization of the nature of electrical resonance. He planned to develop wireless communication through the earth by means of his air-core transformers. Soon he progressed to the notion that power itself could be transferred. Even working eighteen hours a day, he had not enough time for the ambitious program he undertook. During this period he discovered, independently, X-ray phenomena of the type that Roentgen would soon announce. But Tesla never claimed his system was similar to Roentgen's. All he noted at this time was a type of "very special radiation". With it, he was able to get shadowgraph pictures through a human head—at a distance of 40 feet!

He turned his attention to atmospheric phenomena and declared that the *aurora borealis* was caused by expulsion from the sun of particles of high electrical charge. Professional astronomers laughed at such an idea; after all, they knew that the sun was 93 million miles away. He further convinced them of his eccentricity with a casual statement about the "dozen or so" planets of the solar system. Then he announced his detection of mysterious rays bombarding the earth, of hundreds of millions of volts in energy. A decade later, in 1909, W. H. Pickering announced the probability of a trans-Neptunian planet. In 1930, such a planet was discovered photographically and named Pluto. Robert Millikan announced the existence of cosmic rays in 1926 and thereby won a Nobel Prize in physics.

The above were merely side interests. His main curiosity was in resonance phenomena. Aside from electrical oscillations, Tesla had developed several interesting mechanical

resonators, testing their low frequency mechanical vibrations and their effect on the human body and on various materials. Noticing the invigorating effect of the vibrations, he was induced to construct a small massager for the barber of one of his assistants—the ancestor of the same massager the barbers of today use. Another of his vibrating machines consisted of a platform on which one could stand. The platform was connected to a large motor which could be adjusted for different rates of vibration and which created invigorating sensations in the human body. Author Sam Clemens had become a close friend of Tesla and visited the inventor's laboratory many times. Tesla admired Clemens and claimed that one of "Mark Twain's" books had hastened his recovery from a youthful illness. One day, Clemens tried the platform and found it so refreshing that he would not get off, even at the urging of his friend, Tesla. Suddenly he stepped down and demanded petulantly to know "where it was". Smothering a smile, Tesla pointed the way to the rest room, where Clemens hastened. At certain rates, the curious platform had an irresistible laxative effect.

Another of Tesla's mechanical oscillators had more serious ramifications. Tesla had noted that gentle application of power at the natural resonant frequency of a material would set up strong vibrations within it, just as it is possible for an opera singer's voice sustaining one note to sometimes shatter glass. Tesla attached his puny device to a strong vertical steel girder in the laboratory. It seemed improbable that any significant action would occur. He activated the device, which was described later as small enough to slip into one's pocket. It was automatic in operation, in that it would "hunt" for the natural frequency of the substance it was attached to and then lock in step and reinforce the resonant wave. At first, nothing could be noted in laboratory. However, in other parts of Manhattan Island matters were quite different. The strata of sand beneath the surface transmitted the vibrations exceeding well, whereupon they reflected from the granite layer of bedrock. Since the vibrations were sustained by the mechanical oscillator, the power of the waves constantly grew. Shortly, windows were cracking, plaster falling, furniture

moving wildly about. The man-made earthquake began at some distance from the laboratory and slowly moved in toward the source centre. By the time the shock wave impinged on Tesla's building, local police were deluged with reports. Officers were sent to the laboratory. When they entered, they found Tesla smashing the oscillator with a sledge hammer. He had realized what must be happening and taken the swiftest action necessary to cease his experiment. The police had been right in believing Tesla to be involved—after all, anyone who could make lightning in the laboratory must be responsible for other strange occurrences.

Tesla later calculated that his innocent-appearing device was capable of much greater damage. He never released specifics on its construction, prudently, and never resumed such experiments. Later he claimed that with it he could have destroyed the Brooklyn bridge within an hour, or "could now go over to the Empire State Building and reduce it to wreckage in a very short time." At least one published estimate of the time necessary was fifteen minutes! Lest someone think this an idle boast, recall that soldiers break step when marching across a bridge. Further, the infamous "Galloping Gertie", a bridge across the Tacoma Narrows built in 1940, showed all too clearly the result of destructive vibration. When completed, it was the third longest suspension bridge in the country. Four months after its completion, a wind storm, with gusts to 42 mph, well within the calculated safety limits, started erratic vibrations in its span. After four hours, waves of thirty feet were passing along. Then it began undulating from side to side. Four more hours saw 600 feet of the centre span plunge into the Narrows. The 1000-foot side spans followed. Anyone who has seen the film of this bridge swinging from side to side in a mad dance will acknowledge the effects of internal vibration.

On the night of March 13, 1895, catastrophe of another sort hit the Tesla laboratory. A fire razed his building, destroying several years' work, most of Tesla's awards and momentos, what notes he did keep. Fortunately his prodigious memory kept the loss to a minimum, but almost all his experimental equipment was lost. He opened a new laboratory at 46 E. Houston Avenue in July of that year and went on with his work.

By September of 1897, he had filed and received U.S. Patents 645,576 and 649,621 —which have been called the fundamentals of radio broadcasting. He was now ready to demonstrate for the public his new wonders. Always the showman, he booked Madison Square Garden and put on a demonstration of what we would refer to as a radio-controlled boat. He called his remotely-controlled devices "telautomatons". Thousands of people saw a small craft with antennas which could be ordered about at will. Tesla had had constructed an immense tank, in which the boat was placed for the demonstration. The model craft was controlled by a Tesla wireless transmitter and could follow its orders even under water, for it was also a submarine!

This alone would have been sufficient to win him undying fame, had he pursued it monomaniacally. But for Tesla it was not yet enough. His idea of good transportation was a vessel which did not have to take its fuel along, but could receive it as electric power via a broadcast system. Once he had achieved the means of sending signal power, he believed that he could transmit power enough to drive ships and eventually aircraft.

Tesla had advanced in his research to the point where he was able to build a 5 million volt oscillator in his New York laboratory. He was already using lower-potential oscillators as a drive for wireless fluorescent lamps which lighted the laboratory. The big job was used to test his theories of energizing the earth to transmit power by conduction. He recognized that he had reached the limits of safe operation within the confines of the city and proceeded to set up a new laboratory near Colorado Springs. Local entrepreneur, Leonard E. Curtis had promised land and all the electric power he needed, reasoning that a great scientific name such as Tesla's would bring a good deal of attention to the community.

The new laboratory was at an ideal location. Colorado terrain is a great producer of natural lightning and Tesla was able to devise equipment which would record the magnitude of the blasts. He determined that standing waves were set up by the lightning bolts—as storms moved further away, the recorder invariably showed peaks and troughs in the received energy. This further

substantiated his theory of earth conduction. The additional data he obtained aided his production of artificial lightning, perhaps with a view to controlling the weather, as he had fancied long before. However, his present interest was the development of practical wireless transmission of power in commercial quantities. Tesla's apparatus depended for its effect not on electromagnetic radiation, as some have mistakenly believed, but on massive electrostatic action. Indeed electromagnetic dispersal of power was wasteful, in Tesla's system. His system used a "magnifying transmitter," which was a gigantic Tesla coil, driven by thousands of horsepower. The secondary was a quarter-wavelength coil, one end grounded, the aerial portion attached to an immense copper electrode. Once the generator attained full power, the aerial electrode acted as one plate of an artificial condenser, the ground point being the other. In this way, Tesla pumped enormous quantities of electricity into the earth. Some 200 kw was the rating of his Colorado installation.

While weeks of labor turned into months, and the barn-like building he had had erected became stuffed with equipment, his workers had no clear idea what exactly was to happen. At last all was complete and Tesla explained to them; there was a nervous exodus for the door. Only one old assistant dared to stay. Tesla stood outside, conveying his orders to Czito, the assistant, by hand signals. At first, the generator, which drew its power from the commercial ac mains, was only energized a little. Then the power was slowly increased. With each step up in power, changes occured at the copper aerial electrode, First there was only a violet corona discharge. Then, as more power was fed to the system, sparks began to snap and hiss. At the half-power point, bolts of raw electricity leapt from the electrode. As the system neared full power, artificial bolts of lightning, thick as a man's arm, snapped forth, fifty, a hundred, then almost two hundred feet in length. This secondary effect was natural, a sign that the electrostatic equilibrium was being disturbed. When the system stabilized, the lightning would end. Then, as they reached full power, all activity ceased. Tesla ran inside, saw that he was no longer receiving power from the commercial lines. He called the power company.

"You've ruined my experiment," he told them.

"And your experiment has ruined our station," was the reply. "You overloaded the generator and it caught fire."

Humbled, Tesla took Czito to help him set things right at the power station.

It has been stated that Tesla failed in his attempts to transmit power, but this writer believes that other factors became predominant. There are pictures extant of Tesla's apparatus in operation. In one instance, he demonstrated for the press the new system. A receiving circuit was set up twenty-six miles away from the "magnifying transmitter" and 200 50-watt incandescent bulbs were lighted to full power; this, with the transmitter at a low output. Tesla claimed a 95% efficiency for the new equipment.

Tesla was fully satisfied with his results and evidently the U.S. Patent Office concurred, as they issued a number of patents on wireless power transmission. However, when Tesla returned to New York to raise capital for a commercial system, he was unable to. Investors could not see what profit they could make from a system where anybody anywhere could use the power fed into the earth. Let it be said that practical financial considerations of this type were never Tesla's strong suit. The single greatest flaw of this scientific Jove was complete lack of a hard-headed business sense. He further compounded his errors by an overly generous nature.

Those who infringed on his patents were never attacked by him personally, as he considered time taken in such undertakings as wasted. He believed he could never run out of new ideas and inventions. He preferred the wealth of discovery in the laboratory. Also, his great goodwill led him to the naive expectation that, when he had produced a means of improving the human condition, he would be appropriately rewarded by a grateful humanity. His polyphase power distribution system had already improved man's lot by substituting cheap electrical power for manual work in many areas. His new system would make electrical power available in the most remote, inaccessible and impoverished places.

Tesla, returning to New York City in the summer of 1900, found himself in the same situation he had been in in 1882—he had

a wonderous discovery, but could not interest anyone in it. The financiers asked if he had not something else they could capitalize on. He stated that he could adapt his system as a "world broadcast plant". With it, he asserted, he could provide "interconnection of existing telegraph and telephone exchanges *all over the world;* establish a secret and non-interferable government communication service; maintain universal distribution of news; establish a world-wide system of musical distribution; maintain accurate time signals to clocks everywhere; provide full facsimile transmission; send accurate navigational signals"—among other possibilities.

"A cheap and simple device, which might be carried in one's pocket, may then be set up somewhere on sea or land, and it will record the world's news or such special messages as may be intended for it," wrote Tesla, concerning his "World-system".

The men of money were skeptical; Tesla promised much. Still, he had delivered on his claims before; the polyphase ac system in general use now was silent testimony to this man's genius. Then J. P. Morgan made a gift to Tesla of a sum which was never disclosed, but estimated to be from $150,000 to twice that amount. James S. Warden, manager of the Suffolk County Land Company made available to Tesla two hundred acres of his company's tract at Shoreham, Long Island, about sixty miles from New York City.

A large brick building was soon erected and a great, wooden tower was being built. An all-wood structure was specified, because of the enormous voltages the plant would handle. Stanford White, the eminent architect of government buildings of that era, provided the plans for such a structure. The tower was some 187 feet high, and many people snickered, because they knew such a wooden tower could not stand, or if it did, would not be able to resist high winds. A torus-shaped copper electrode of copper, 100 feet in diameter, was to top the tower. This was later changed to a hemispherical shape. Needless to say, the equipment being installed—most made to order—the tower itself, and the cost the copper electrode and changes engendered took all the money Tesla had. The smaller investors stood by, waiting to take their cue from Morgan. That financial baron had

made a good deal of money on the General Electric Company, whose financing he had accomplished, and the others reasoned that if he was backing Tesla again, they would follow. They did not know that the sum was a personal gift, not a business investment. When Tesla ran into financial difficulties and Morgan did not rescue him, rumors arose that Morgan had withdrawn his support in dissatisfaction. Tesla was unable to raise further capital and the "World-system" went down the drain. A couple of personal friends extended sums, which Tesla used to pay off creditors.

It may be argued that the system was a technological failure, that Tesla was unable to produce the results he had claimed. However, his earlier experiments in Colorado had been sufficiently practical to win him U.S. patents. It is hardly necessary to say that the Patent Office does not grant patents on conundrums such as perpetual motion machines.

Tesla wrote of this failure: "My project was retarded by the laws of nature. The world was not prepared for it. It was too far ahead of time. But the same laws will prevail in the end and make it a triumphal success."

Nevertheless, Tesla did not regain his stature as creator after this episode and his twilight years were taken up with ever smaller practical projects and ever more grand dreams and theories. His next major enterprise was the successful development of a bladeless turbine, another revolutionary idea. The Tesla turbine used a rotor composed of a series of smooth discs. Steam entered through center porting and flowed in spiral lines around the discs, dragging them along by virtue of viscosity and adhesion. The first experimental model, built in 1906, was six inches in its largest measurement, weighed about 10 pounds, and developed 30 horsepower. But it was another case of being too much ahead of time and revolutionary. Though the high cost of machining the conventional turbine bladed rotor made the Tesla approach attractive from a cost viewpoint, the conventional turbine was already highly developed and accepted.

In 1911, Tesla adapted the radio-control apparatus he had developed for his 1898 submarine demonstration to an airplane and presented his plans to the War Department, where the scheme was laughed at. Of course, this was the same period when Robert Goddard, the American father of modern rocketry, was ridiculed as a crank by the military savants of this country. By 1936, the aging Tesla had completely recanted in his idea that devastating weapons would make Mankind turn away from war; he claimed that he had conceived a 'death ray,' but would not give his calculations to the government. Fantasy, some say. Yet it is a fact that the Federal Bureau of Investigation impounded his papers when he died in 1943, and for all this writer can discover, still has them. The death ray would have been only a defensive weapon, because it required staggering amounts of electrical power. It would have secured a country against enemy air attack. As early as 1917, Tesla had thought about this problem and had described the possibility of apparatus which could broadcast short-wave impulses and receive reflected waves which would be displayed on a fluorescent screen—radar, in short.

Fortunately, Tesla wrote a good deal in later years. Gernsback's "Electrical Experimenter" published a series by the scientist starting in 1919, which gives some valid

biographical data and a good review of his discoveries and plans. Tesla also wrote on diverse subjects: van de Graaf generators, Servian poets and translations of their works, the compass, the moon's rotation, woman's role in future society. Perhaps the writing that caused the greatest reaction from the public was "The Problem of Increasing Human Energy," in Century magazine, June, 1900. Instead of a dry scientific dissertation, Tesla took a philosophic approach, derived in part at that time of a mechanistic view of Man. In this massive article, he discussed such topics as public health, morals, diet, the outlawing of war, his telautomatics and their potential use, harnessing solar energy, the iron industry, the coming age of aluminum, new power sources and prime movers, wireless and the secret of tuning, and the practical possibility of interplanetary communication.

Concerning the latter, Tesla had claimed that he had received radio-type signals which could only have come from outer space. Conventional people, both scientists and laymen, laughed. Marconi claimed the same results. Many years later, Project OZMA's radio telescope began probing the stars for intelligent signals. And the recent International Astronautical Congress in Rome heard a paper which reviewed the findings of Tesla, Marconi and the Scot, David Todd.

In 1912 the Nobel prize in physics was awarded jointly to Tesla and Edison. Though he could have sorely used the $20,000 prize money, he refused the honor. Tesla called himself a discoverer and Edison an inventor. "Placing the two in the same category would completely destroy all sense of the relative value of the two accomplishments," he wrote. By a great irony, a few years later friends persuaded Tesla to accept an honor presented by the American Institute of Electrical Engineers—the Edison medal. In 1936, the Yugoslav government awarded an honorarium of $7,200 a year to the aging scientist.

On January 7, 1943, Tesla passed away, ignored by the world he had helped to energize. He had once written: "The opinion of the world does not affect me. I have placed as the real values on my life what follows when I am dead." A prophetic statement—for less than a year after his death, the United States Supreme Court rendered a decision that the Marconi radio patents were invalid, on the basis of prior work by Tesla and others. Had this significant decision been reached during Tesla's lifetime, he might not be all but forgotten today. Every school child knows of Edison. Most people have heard of Marconi—but the name "Tesla" raises blank stares. Of course, much has been written about Tesla concerning his eccentricities, his strange beliefs and habits—sensation-mongering that has led attention away from his accomplishments. However, the summation must be that his was a brilliant career—he led the way for the world during the peak of his abilities, and as his influence ebbed, he pointed to future realizations for others. His successes are beyond dispute. His failures may yet yield practical results. ■

ATTENTION

Last minute news! W3EFI and WA5AXW/3 are sending up a balloon containing a ½ watt transmitter sending a series of dits. The unit will go to 50,000 ft. and will be launched February 26th. Frequency will be 28.250. Send signal report and time/date heard to: Ken Hollan, W3EFI, Fairhaven, Maryland, 20796. Future balloons will include telemetry and more sophisticated equipment. Hopefully we will hear more from these enterprising hams.

Go Mobile!

Joe Hannigan WB6ACM
887 *Islay* 3
*San Luis Obispo, CA*93401

So you've decided to go mobile. Have you considered the problems you may face when it comes time to put the rig in the car?

Have you decided on your equipment? Let's think about it for a while.

High power is not too practical for mobile operation. A medium powered transceiver will work around the world. Also, the lower power adds a challenge to the game, and saves batteries and generators as well.

Unless you have one of the larger luxury cars or have no family, you'll want a unit that takes up as small a space as possible (some 300 watt units take up less than a cubic foot).

If you're not a VHF'er, you'll want a rig that will work on 80 through 10 meters and an antenna that covers those bands. Long whips may cause a problem with mounting and can be dangerous when you go around a corner (it might wrap around something or someone)!

Now, let's see what problems lurk ahead.

The first step in the installation is to mount the antenna. A body mount should be used, because it will give greater efficiency by providing added height. Place the mount on the top of the left rear fender. This position will give a good radiation pattern. A better pattern can be achieved by mounting the antenna in the center of the roof, if you have the courage.

A bumper mount can also be used, but a poorer ground may result.

The coaxial cable should be run from the antenna mount to the position chosen for the transceiver, usually be under the dash.

Take care to protect the cable from fraying when it passes through holes in the body of the car by installing grommets.

The transceiver should be mounted as far toward the firewall as possible to give the passengers as much room as possible. This saves the equipment from being kicked when they enter the car.

Make sure the installation is as vibration proof as you can make it so that the printed circuit boards won't be broken and other parts shaken loose.

The power supply is next. It should be placed as far in front of the engine and radiator as possible. Power transistors generate a large amount of heat, and need to be kept cool. Position the supply so it will be in an area of maximum air flow. It unit should be mounted flush with the body of the car to insure a good ground, and to allow the body to act as a heat sink.

Run the cables from the power supply to the transceiver, but be sure to remember the grommets! Keep the leads as short as possible.

Remove the fuse from the power supply and connect the battery cables. These cables should be as short as possible (no more than three or four feet), or poor voltage regulation will result. Put the fuse in the supply, and you're almost ready to go on the air.

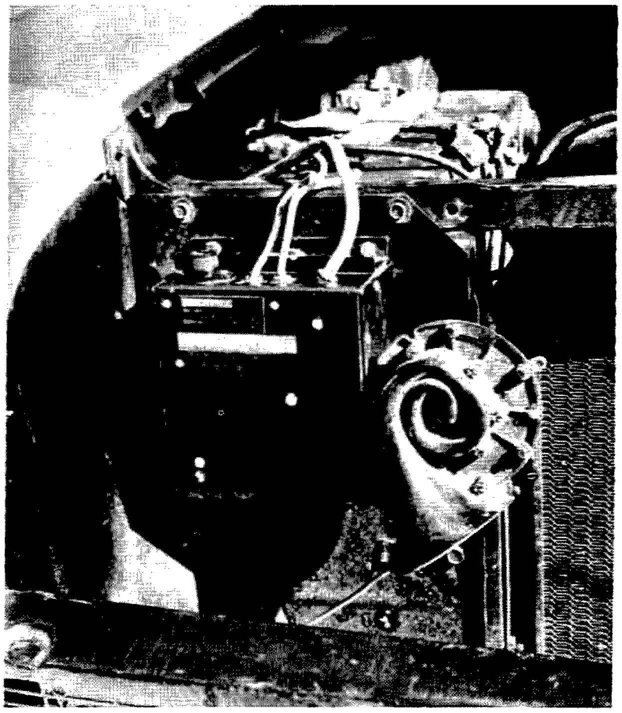
You still need a speaker, but most cars have one mounted for the car radio. Clip the speaker's hot lead and install an spdt toggle switch. Attach one lead from the car radio and one lead from the transceiver, and use a common ground for both.

Don't turn the rig on yet!

Check your job of wiring. A little precaution now can save time and money. If you're sure everything is wired correctly, throw the switch.

Run tests at low power first and check

The advantages of a collapsible whip antenna are many. You may want to reinforce the whip to halt wild swaying when cornering by using an insulated brace mounted on the car body.



Special attention should be given mounting the power supply. Be sure plenty of air reaches it and make it as water tight as possible. Keep all cables as short as is practical.

the standing wave ratio by inserting an SWR bridge in the antenna line. An SWR of 2:1 is reasonable.

Now try full power, and have a friend listen to your signal, checking for clarity, strength and frequency drift (which could be caused by having too long a cable from the battery to the dc supply!)

That about does it. The pleasures of mobile operation await you.

With the current sun spot activity, world wide communications are possible using low power on 20 meters. If you like DX (who doesn't), now you can enjoy it while you take a Sunday drive, or while you're caught in a traffic jam on the freeway.

If you can't hear the weak DX stations because of the ignition noise, try one of the commercially made suppression kits.

I work the VK's and ZL's regularly from California with S9 plus signals and DXCC is about 50 countries away. You can enjoy mobiling, too, and share the adventure. But be sure you do a good job when you install the rig. It'll pay off. . . . WB6ACM

Getting Your Extra Class License

Part I — AC-DC Theory

Having completed the study course for the Advanced Class examinations, let's turn our attention to the Extra Class ticket and its technical requirements.

The official FCC study list to prepare for the Extra Class exam includes 79 questions, most of which appear much more forbidding than do the 51 for the Advanced Class license. However, if you've stuck with us this far you may be amazed at how much of the required information you already have!

We'll tackle the Extra Class just as we did the Advanced, by selecting several questions from the study list which deal with the same general subject, and then exploring that subject in detail. We'll also continue to paraphrase the official questions into broader queries, to assure that we get all the necessary information rather than just enough for memorization.

At times, we'll refer back to the Advanced Class articles; in several cases, our broader questions covered not only the data needed for Advanced tickets but that for Extra Class as well.

To kick off this course, let's take the group of questions dealing with ac and dc theory. We covered much of the information needed to answer these questions last time out, in the final installment of the Advanced Class course, and so this is a good time to get the rest of it.

The FCC study list questions included in this group are (all numbers, as always, are from the study list):

10. What is the meaning of the time constant in a resistance-capacitance circuit?
16. What are inductive and capacitive reactance? How are their phase angles related?
25. How do mica and paper dielectric bypass capacitors compare at different frequencies?
26. How do filter capacitors made of mica and paper compare at different frequencies?
30. What does the term "power factor" mean in reference to electric power circuits?

All of these questions deal with characteristics of capacitors and inductors—even number 30. Last time out we went into great detail concerning reactance, so we'll refer you back to that one so far as question 16 is concerned. The rest of the group can be covered by posing four questions:

First would come "How do capacitors and inductors work?" With that settled, we can ask "What are time constants?" to get a handle on question 10. While we find out how the devices work we'll meet the term "dielectric" and so a natural successor in our list of questions would be "What is a dielectric?" There, we'll find answers which apply to questions 25 and 26. Finally, we'll ask "How about power factor?", and dispose of the final question from the original list for this month.

Ready? Let's get on with it.

How Do Capacitors and Inductors Work? Both capacitors and inductors are, essentially, energy-storage devices. Each of them works by storing energy, but they do so in opposite ways.

Energy may be stored in many different ways. A living creature, for example, stores heat energy by chemical action which transforms the energy already stored in its food into another class of compounds more suitable for storage in its body. Both the food and the body itself are basically chemical structures—but the energy which is stored,

and which powers the creature, is that of heat.

Similarly, a storage battery or storage cell stores electrical energy by chemical action. The electrical energy causes chemical changes within the storage cell. These changes turn the electrolyte of the cell from its original chemical compound into another. When, sometime later, the electrical energy is needed, the second compound is transformed back into the first—and in the process, the electrical energy is made available to an external circuit.

The energy storage action of capacitors and inductors is somewhat more direct in that no chemical transformation occurs. The capacitor stores electric (sometimes called electrostatic to distinguish it from "electricity") energy by creating a temporary "electric field", while the inductor stores magnetic energy by forming a magnetic field. Since "electricity" always involves *both* electric and magnetic fields, storing either kind of energy in its own field is a direct storage of "electricity".

A capacitor consists simply of two conductors, of any sort at all, separated by an insulator known as the "dielectric" of the capacitor.

An inductor, on the other hand, consists of only one inductor, surrounded by its magnetic field.

You can see from these definitions that *any* wire carrying an electric current must be an inductor, and any two wires which are not connected to each other must form a capacitor. This is absolutely correct.

In fact, this "stray" capacitance and inductance which is present in every electrical circuit is one of the biggest problems the VHF or UHF worker must battle. The inductance of a 2-inch length of hookup wire is not very large; normally you can merely ignore it, but when the frequency gets high enough it may be *more* inductance than the design calls for. Similarly, the capacitance from one pin of a tube socket to an adjacent pin is usually less than ½ pF, which again is a very small value—but when the frequency is far enough up there, this may be more than the maximum allowable for a circuit.

In the rather unrealistic world of "pure" theory, though, we can *imagine* such things as perfect resistors which have no capacitance or inductance, perfect inductors with no capacitance, and the like. And even in the more realistic world we live in, most of the time we can consider all the capacitance in a circuit to be contained in those components called capacitors, and all the inductance to be in the inductors.

These "normal" capacitors usually have plates and dielectric made out of thin, rather flexible material, and rolled into a cylinder or similar shape to occupy the least space. We'll look at the physical details of the various types of capacitors in more detail when we examine the properties of the dielectric, a bit later in this session.

The "normal" inductor usually has its single conductor wound into a coil, so that the magnetic field tends to be concentrated in a single region. This permits the field to store more energy in the same space, than would be the case if the conductor were stretched out straight. Inductors for *rf* use frequently use nothing at all to strengthen the field, but you will often find ferrite slugs used as "cores" in the inductor. The same current can create a stronger field in the ferrite core than it can in air, thus increasing the inductance of the coil. Audio inductors almost invariably use either ferrite or soft iron cores.

Brass slugs are also used in *rf* coils; they serve a purpose opposite to that of the ferrite. Where the ferrite core increases inductance of the coil, the brass slug decreases it. Effectiveness of either type of core depends upon how much of the field is occupied by the core; this permits adjustment of inductance by moving the core in or out of the coil.

Capacitors and inductors store energy without regard to whether ac or dc is flowing in the circuit which contains them. However, their energy is "polarized"; that is, a capacitor charged with dc will retain the polarity of its charge. In an ac circuit, the polarity reverses every half-cycle, and as a result the capacitor discharges at every reversal and re-charges with opposite polarity. This effect is the cause of phase shift, which we went into in such detail last time.

Both capacitors and inductors store energy by converting it from a moving "wave" into a stationary "field"; just exactly *how* this is accomplished is still not known, but the theoretical boys are pretty well certain that it's somewhat similar to the stretching of a rubber band which converts energy of

motion—kinetic energy—into energy of tension—potential energy.

The capacitor works on voltage, and stores it in an electric field, while the inductor works on current and stores it in a magnetic field.

Either kind of field is unstable, once energy is stored there. The energy, like the stretch of the rubber band, is eager to get out. That's what makes the whole idea practical.

The energy-storage aspect of capacitors and inductors is most apparent in some of their non-radio, dc applications. For example, a photographer's strobe-light unit uses large capacitors to accumulate a high-voltage charge. This charge is measured in watt-seconds, and a typical strobe operates at 50 to 100 watt-seconds, with anywhere from 250 to 2500 volts. The charge accumulates over a period of several seconds; some units take as long as a minute to re-charge after each shot. This means very little power is necessary. The discharge, however, happens in a very few thousandths of a second, so that during that time you have the equivalent of a 50-kilowatt light.

Another example, using an inductor rather than a capacitor, is the Kettering auto ignition system, which was standard equipment on all autos from the days of the magneto until the rise of transistorized ignition and is still widely used. Here, the ignition points are closed most of the time and a current of several amperes flows through the ignition coil primary. This is a rather sizeable inductor, and a large magnetic field results which stores much energy. When the points open, the primary circuit is broken. The current no longer flows, which releases the "stretch" holding the field in place, and the magnetic field collapses. This collapse releases the stored energy of the field, which reappears as high-voltage pulses at both the primary and the secondary windings.

The purpose of the whole thing is to produce a 25000-volt pulse at the secondary winding; the 250 to 500-volt pulse in the primary circuit is an unwanted side effect. That's the purpose of the capacitor known to mechanics as "the condenser" across the points; it stores the energy of the primary pulse and returns it to the circuit.

These examples bring out one of the fundamental differences between energy storage in a magnetic field and in an electric field. A capacitor is charged by application of voltage, and the electric field will remain there—stretched—until you discharge it. The inductor is "charged" by applying current, but the magnetic field remains only as long as current flows and "snaps back" as soon as current stops.

What Are Time Constants? It would appear, from what we've seen so far, that any capacitor could store as much energy as any other capacitor. If you qualify this by adding to it the words "of the same capacitance", the statement is true. The only factor affecting the amount of energy which a capacitor can store is its capacitance, which is determined by the *area* of its conductors or "plates" and the thickness of its dielectric.

Practical capacitors, of course, have a few other limitations such as voltage rating and self-inductance, but we'll get into these later. The essential point at this stage is that the size of the field is limited only by physical characteristics of the capacitor itself and not by any other component in a circuit.

In most if not all applications of capacitors, though, we must consider not only the capacitor but also the rest of the circuit—and the other parts of the circuit *do* affect the size and strength of the field at any specific instant.

For instance, let's look at the capacitor as being something like a large water glass. It can hold a pint, let's say. We can fill it up from a gallon bucket in a hurry, or we can trickle water in from a dripping faucet. The glass will still fill to its pint capacity—but it will take longer.

A capacitor being charged with dc reacts in just the same way. If we connect it directly to a battery, it will charge rapidly until it reaches approximately the same voltage as the battery. If we connect it to the battery through a large resistor, which reduces the current flow to a mere trickle, it will take longer to charge—but it will eventually reach the same voltage, if we leave it connected long enough.

That's the whole meaning of the term "time constant". As it turns out, we can connect a 1-mfd capacitor in series with a 1-megohm resistor to a 12-volt battery, and the capacitor will have reached a voltage of about 8 volts after 1 second. If we connect a 2-mfd capacitor in series with that same 1-megohm resistor, it will take twice

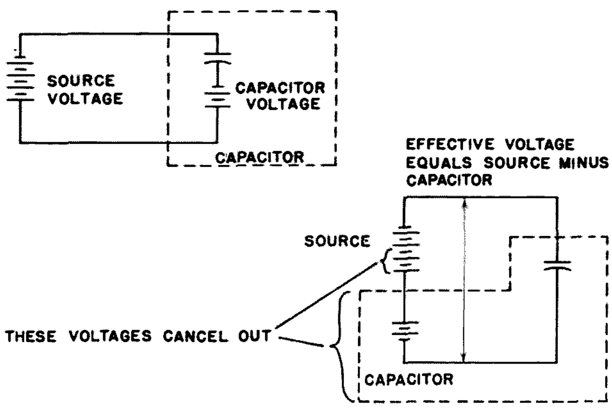


Fig. 1—When a capacitor is charging, three voltages must be considered. The obvious one is the voltage of the source from which the charge comes. However, as charge accumulates on the capacitor it takes on a voltage which acts to oppose the source voltage; the effective voltage available to keep charging action going is then the source, minus the voltage on the capacitor. This is why charging slows and eventually apparently stops when a capacitor is connected to DC.

as long to reach the same voltage since the capacitor is twice as large. However, if we use a 2-mfd capacitor and a ½-megohm resistor, the time will remain constant.

For capacitors, time constant is defined as the product of resistance in ohms times capacitance in farads. Resistance in megohms times capacitance in microfarads gives the same result, and the resulting time constant is measured in seconds. In our examples, 1 megohm x 1 microfarad = ½ megohm x 2 microfarads = 1 second time constant.

The same rules apply to inductors, but the R-L time constant is not nearly so widely used as is the R-C time constant. We'll concentrate on the R-C case.

You probably noticed that in our examples above the capacitor had charged only to about 8 volts, rather than to the full battery voltage, after 1 time constant's worth of time had elapsed. Why?

The reason is a little tricky, and most texts resort to differential calculus to explain it. Let's see if we can't make it clear by using only simple arithmetic.

When we set out to charge a capacitor, it may look as if there's only one voltage to worry about—but actually there are three. The *source* voltage (our 12-volt battery) is the obvious one. The hidden ones are the *capacitor* voltage and the *effective* voltage. The schematic in Fig. 1 shows what they are.

The capacitor voltage can be thought of as a battery inside the capacitor. Actually, it's the voltage of the charge which we have *already* stored, and since in the series circuit which the charging current must traverse it's opposing the source voltage, it makes the circuit act as if the source voltage were continually decreasing.

For instance, when we have the capacitor charged to 8 volts in our earlier examples, the capacitor voltage is 8 and the source voltage is steady at 12. So far as the capacitor alone (without regard to its already-existing charge) is concerned, the situation is the same as it would be if source voltage were (12 - 8) or 4, and capacitor voltage were zero.

This difference between source voltage and capacitor voltage is what we call "effective" voltage. It's the only voltage available to *add to* the existing charge.

When we started, capacitor voltage was zero and the effective voltage was the same as the source voltage, or 12. As soon as the capacitor had charged any at all, though, the resulting capacitor voltage opposing the source voltage began reducing the effective voltage.

When the capacitor reached 1 volt, the effective voltage was down to 11; when capacitor voltage reached 2, effective voltage was down to 10. By the time capacitor voltage was 8, effective voltage was only 4.

It's like an ant crawling up the side of a wall, who covers half the distance between where he is and the top in any given period of time. During the first period, he makes it half-way up. During the next, he gets half-way up the remaining half, or a total of ¾ of the way up from the start. In the next period, he gets half-way up the remaining quarter, or ⅞ of the total distance.

The higher he gets, the slower he goes. Also, you may notice, he will *never* make it to the top of the wall. No matter how high he gets, he can only make half of the remaining distance in the next period of time.

The same thing's true of a charging capacitor. No matter how long you charge it, it can never reach the full source voltage.

In practice, though, it will get so close—within a few million-billionths of a volt—that you can't tell the difference. And the

longer you leave it connected, the closer it will get.

Our R-C time constant, ohms times farads, is simply a convenient and easy-to-use measure of that "time period" in which our poor ant was climbing. There are good mathematical reasons why it works out this way, but for our purposes it's only necessary to know that a capacitor will charge to 63.2 percent of the source voltage during one time constant, and to know that the speed of its charge is always changing as the voltage changes.

Fig. 2 tabulates the three essential voltages at selected time periods between 0 and 10 time constants, for a capacitor being charged from a 100-volt source.

All this time, we've been talking about voltage only—but whenever we have voltage in action, we must have current too. What happens to the current in this circuit?

Initially, when the capacitor voltage is zero, the capacitor acts just like a short circuit so far as the power source is concerned. Theoretically, the current at this instant is infinite; in practice, it's limited only by the resistance of the wires in the circuit and the capability of the power source.

But as soon as the capacitor begins to charge, the capacitor voltage opposes the source voltage as we have seen and shown in Fig. 2, and so the current drops to a smaller value. The higher the capacitor voltage, the less current flows to charge it.

And as a matter of fact, you can use the figures listed in Fig. 2 to determine the current as well as the voltage at any time after charging begins. The same column of figures which shows "effective voltage" applies to current flow.

Initially at 0.0 time constants, the current flow will be 100 percent of that which the external circuit can provide. After 1/10 time constant, only 90.5 percent of the available current will be flowing, and after 10 time constants, current will have dropped to just 45/10000 percent of that available.

The time constant of an R-C circuit has many effects, not all of which are obvious. One of the more apparent is the possibility of using the effect to provide a means of timing events—and this provides the horizontal sweep timing signal for most oscilloscopes. Less apparent is its application to bypass and filtering action.

But in the circuit of **Fig. 3**, for example, if the input signal consists of pulsating dc such as you would get from a full-wave rectifier, and no current were being drawn from the output of the circuit, the capacitor would eventually charge to approximately the peak value of the input signal voltage. Having reached that peak, it would retain that voltage level because the time constant of the R-C network R1-C1 is so long that the capacitor voltage cannot change greatly in the time between the peaks of the input signal.

Time (Time Constants)	Voltages Source	Capacitor	Effective
0.0	100.00	0.0	100.00
0.1	100.00	9.5	90.5
0.2	100.00	18.1	81.9
0.3	100.00	25.9	74.1
0.4	100.00	33	67
0.5	100.00	39.3	60.7
0.6	100.00	45.1	54.9
0.7	100.00	50.3	49.7
0.8	100.00	55.1	44.9
0.9	100.00	59.3	40.7
1.0	100.00	63.2	36.8
1.5	100.00	77.7	22.3
2.0	100.00	86.5	13.5
3.0	100.00	95.02	4.98
4.0	100.00	98.17	1.83
5.0	100.00	99.326	0.674
6.0	100.00	99.752	0.248
10.0	100.00	99.9955	0.0045

Fig. 2—This shows how effective voltage goes down while capacitor voltage goes up. After 5 time constants, capacitor is so close to full charge that it can be considered "charged", but charging continues indefinitely. You can use this for any source voltage by reading the voltage values as being "percent of source voltage".

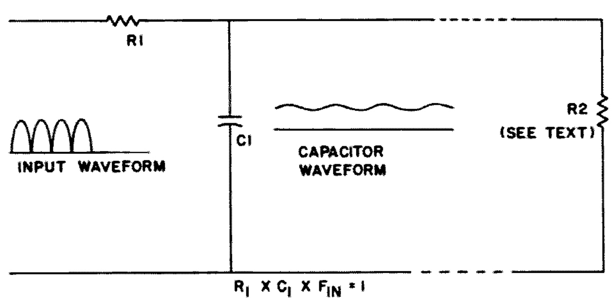


Fig. 3—Time constant of a resistance-capacitance circuit can be used to filter out low-frequency signals, by proper choice of time constant with respect to input frequency and output loading. See text for discussion of resistor R_2 which represents load on the filter and affects actual resistance and capacitance values for any practical circuit.

If the value of R1 is reduced, shortening the time constant, the output signal level would have time to fall back in an attempt to follow the input signal. If R1 were reduced to zero, the output signal might be able to follow the input signal almost exactly and no filtering action would occur.

When a load is applied to the circuit, it acts just as if resistor R2 were connected (unless the load is itself an inductor or a capacitor, and we're not considering that kind of load at this point). Now the charge on Cl is bled off through R2 during the time between peaks, and the output level may tend to follow the input signal.

Increasing CI or Rl, either one, will lengthen the time constant and keep the output level more constant. If Rl is increased, though, less current may be taken from the output; if the time constant is lengthened by increasing CI, the available current will not be reduced.

The exact relationship between time constant of a filter or bypass circuit such as that shown in Fig. 3. and the lowest frequency at which bypass or filtering action is effective, is complicated greatly by the variables always present in practice. These variables include the waveform of the signal to be bypassed or filtered, the current through Rl and that through R2, and a number of other quantities.

A useful rule of thumb, however, is to always make the time constant at least equal to one full cycle of the lowest frequency to be filtered or bypassed. For a low-frequency cutoff of 100 Hz, for instance, the time constant should be at least 1⁄100 second. This would work out to be a 0.1 mfd capacitor for CI and a 100 K resistor at Rl, or a 10-mfd capacitor at CI and a IK resistor at Rl, or possibly a 100-mfd capacitor and a 100-ohm resistor. All three of these combinations provide a 0.01-second time constant and would have equal filtering action; the choice between them would depend upon power requirements and impedance of the circuit being filtered.

What Is A Dielectric? We noted several pages back that a capacitor consists of two conductors, known as "plates", and an insulator separating them, called a "dielectric". This implies that any and all insulators are "dielectrics", and in fact this is true. However, when an insulating material is used primarily as the dielectric of a capacitor several characteristics of the material assume considerable importance. They not only help determine the capacitance of the resulting capacitor, but its useful frequency range of operation, the voltage levels at which it may be used, and the temperatures at which it may be employed.

To help us see just how the characteristics of the dielectric determine all these properties of the capacitor, let's take a rather oversimplified look at the way in which a capacitor stores energy.

All materials, of course, are composed of atoms, and atoms, in turn, are composed of protons, neutrons, and electrons. Only the electrons concern us in this view.

The major difference between an insulator and a conductor is in the way in which the electrons are held to the atoms which compose the material. In a conductor, many of the electrons are "free"—that is, they are able to migrate from one atom to another. Since each electron is a minute negative electric charge, this migration or "drift" of the free electrons is what we generally call an "electric current" in the conductor. The greater the pressure, or voltage, which we apply to the material, the more electrons move—and the larger the current.

In an insulator, on the other hand, the electrons are "bound" to their parent atoms more firmly and are not free to drift. While they can, and do, travel comparatively long distances from their "home positions", the binding forces remain to pull them back into place once any pressure is removed. It's very much as if they were attached to the atoms by rubber bands of various thicknesses.

When we apply a voltage to the conducting plates of a capacitor, the pressure from the voltage source pushes a large number of free electrons onto the negative plate. Since charges of like polarity repel each other, the combined negative charge of all these free electrons pushes the neighboring "bound" electrons in the insulating dielectric away from the negative plate.

The push away provided by the repulsion force is opposed by the binding forces within the dielectric, but in all cases the repulsion force is the strongest and it overcomes the binding forces.

As a result, the electrons of the dielectric, although still bound to their original positions, are pushed out of place and pile up near the positive plate. There, they repel the free electrons in the conducting positive plate, which in turn drift on out of the capacitor into the remainder of the circuit.

The total effect is that a current flows "through" the capacitor—but in so doing,

the binding forces within the dielectric have been stretched to permit the current to flow through.

This tension of the binding forces is usually called "stress",, and *is* the stored energy. So long as the binding forces remain stretched, the energy remains stored within the capacitor. It would be just as accurate to say that so long as the capacitor retains its charge, the binding forces remain stretched.

When a discharge path is provided from one plate to the other, then the binding forces within the dielectric pull the bound electrons back into place. This creates a shortage of electrons at the positive plate and an excess of electrons at the negative plate—but the excess electrons flow through the external discharge path back to the positive plate to make up the deficit there. In the precess, their energy is released as electric energy.

As we said, this is an oversimplified view of the process and makes no mention of the "electric field" associated with a capacitor. The oversimplifications lie in the area of "What keeps the binding forces stretched out?", and any attempt to answer *that* one accurately would lead us far into the depths of solid-state physics and beyond the scope of this study course.

But it may be a bit clearer now just how the physical and atomic characteristics of a dielectric can determine so many of the properties of the complete capacitor, since the dielectric is the place in which the actual energy storage occurs.

For instance, some materials have stronger binding forces than others. The stronger the binding force, the more pressure will be required to put in the same amount of "stretch" or stress. This means that the material with the stronger binding force must require a larger electric charge, if physical sizes are the same, than one with a weaker binding force. Its capacitance, then, must be smaller.

This characteristic is normally called the "dielectric constant" of the dielectric, and is also a measure of its insulating capabilities. The dielectric constant is a number which provides a comparison of the dielectric in question with clean, dry air. That is, air has a dielectric constant of 1. Any material whose dielectric constant is greater than 1 will permit greater capacitance for the same thickness than will air. For instance, a material with a dielectric constant of 2 will make a capacitor having twice the capacitance of one with air as a dielectric, all other things remaining equal, and another material whose dielectric constant is 10 will provide 10 times as much capacitance as air or 5 times as much as the first material.

While the binding force can be stretched over a considerable distance, it cannot be stretched indefinitely. Like a rubber band, it eventually reaches a point at which it snaps. The dielectric material is then permanently damaged. This effect is measured by a characteristic called "dielectric strength", which is usually rated in volts-per-mil. The volts-per-mil is the voltage necessary to cause permanent breakdown in a 1/1000-inch-thick sample of the dielectric.

Very few, if any materials, are either perfect conductors or perfect insulators. The most perfect insulators known still retain a few free electrons and so can act as partial conductors, while the most perfect conductors (at normal temperatures) still retain some resistance. This provides a third factor in the dielectric which affects the capacitor greatly—one called "volume resistivity" and measured in ohms per cubic centimeter. The higher the resistivity, the better the insulating qualities of the dielectric. Surprisingly, some popular dielectrics have rather poor insulating qualities; it all depends upon the particular application!

The fourth major characteristic of the dielectric which has large effect upon the properties of the capacitor is the "dissipation factor". Like everything else, the stretch-and-release action of the dielectric is far from perfect. Not all the energy stored when the binding forces are stretched is turned back when the stress is released. Some of it is dissipated as heat within the dielectric.

The "dissipation factor" is the ratio of energy released to energy lost, and like dielectric constant is measured by comparison to air. Air has a dissipation factor of 0.0; most if not all other dielectrics have higher factors. In most, it is also frequently sensitive, with losses increasing as the signal frequency goes up. This is the principal reason why some types of capacitors are suitable only for use at dc or audio frequencies, while others work well up into the UHF spectrum.

A perfect dielectric for an all-purpose capa-

citor, then, should have a high dielectric constant to keep the capacitor small; very high dielectric strength to permit its use with high voltages; high volume resistivity to prevent loss of the stored energy by internal leakage; and a low dissipation factor so that most of the stored energy will be returned to the external circuit upon demand.

Few dielectrics meet all these requirements—and that's why we have so many different types of capacitors available. Of all the various insulating substances available for use as dielectrics, only six major types have found wide use, with a seventh (not usually considered to be an insulator) coming into popularity for special applications.

The classic dielectric is, of course, air. Its dielectric constant is so low, however, that air capacitors of practical physical sizes are limited to small values of capacitance.

A substance even better than air as a dielectric in most of the critical factors is ruby mica. Again, though, the dielectric constant is relatively low and so mica capacitors of any appreciable capacitance are extremely large.

The most popular dielectric for general purpose use through the years has been paper. The paper is almost always treated with special materials to modify the critical factors, but dielectric constant is always high. The principal problem with paper as a dielectric is threefold—the dissipation factor, while reasonable at low frequencies, becomes excessively high in the *rf* region; the dielectric strength is not always great enough to get adequate capacitance and voltage ratings at the same time; and the physical construction, being so much like a coil, introduces undesirable self-inductance.

Despite these limitations, paper capacitors are still the most widely used in moderate capacitance ratings for dc, audio, and low-frequency *rf* applications—and their only serious rivals are members of another very similar class.

These rivals are the plastic capacitors, which use any of a number of types of plastic as the dielectric. The qualities of the plastic can almost be tailored to the needs of the capacitor designer, permitting near-perfect capacitors for any specific purpose, but the physical limitations remain.

Similar to plastic capacitors in some ways, and vastly different in others, are the capacitors which use ceramic dielectrics. Most of us tend to think of ceramic capacitors as relatively recent devices. Yet glass is a ceramic material—and the very first capacitors, the venerable Leyden jars which date from before the invention of the electric battery, used glass as their dielectrics.

Like plastics, ceramics can be made with almost any characteristics. "Ceramic" capacitors fall into two broad classes, though. One of these—which includes glass—is similar in most ways to mica. It offers extreme precision of manufacture, excellent stability of characteristics over wide temperature ranges and humidity conditions, and moderate values of dielectric constant. The other is not so stable, but has the highest dielectric constant of any type of insulator in wide use except one. This type of ceramic is used in the popular disk bypass capacitors and other units which feature high capacitance in small size. Unfortunately, its resistivity and dissipation factor prevents its use in general applications and limits it to bypassing and filtering.

The sixth type of dielectric provides the highest dielectric constants of all, but at the cost of having the lowest dielectric strength and resistivity, together with polarization effects which restrict its use to dc circuits. This is the electrolyte dielectric, used in electrolytic capacitors.

An electrolyte dielectric is a chemical solution which, in the presence of voltage stress, produces an ultra-thin oxide coating on one face of one plate of the capacitor. This oxide coating is the actual dielectric, and the electrolyte actually serves as the other plate of the unit.

When an electrolytic capacitor is manufactured, its dielectric is "formed" by operating it for a specified time at specified voltages. The unit should never be used at higher voltages than it is rated for—and likewise should not be allowed to stand idle for excessive periods of time, or the oxide coating may go back into solution and cause failure of the unit when voltage is applied.

Because of its unique characteristics, the electrolyte dielectric is used mainly for filter capacitors where the need is for largest possible capacitance values with moderate physical size, and comparatively large amounts of leakage can be tolerated.

Material	Dielectric Constant (relative)		Dielectric Strength (Volt/mil)	Volume Resistivity (ohm/cm³)	Dissipation Factor (relative)	
Frequency	60Hz	1 MHz			60Hz	1 MHz
AIR	1	1	1200	very high	0	0
(standard for comparison of dielec. constand & dissipation)						
MICA						
from	5	5	3800	5×10^{13}	.005	.0003
to	9	9	5600	5×10^{13}	.005	.0003
PAPER						
plain	3.3	2.8	202	not rated	.01	.05
waxed	14.2	5.4	——	abt. 10^{6}	.12	.145
PLASTICS						
from	1.03	1.03	200	10^{7}	.00005	.00007
to	11.4	7.0	2000	10^{18}	2.0	.140
PRECISION CERAMICS (including glass)						
from	3.78	3.78	200	7×10^{7}	.0006	.00001
to	29.5	29.5	410	10^{19}	.03	.0075
OTHER CERAMICS (bypass only)						
from	168	167.7	75	10^{12}	.006	.0002
to	1250	1143	.100	10^{14}	0.56	.0105
ELECTROLYTES (not rated specifically; approximate values)						
Alumin	45	——	450 V max	very low		very high
Tantal	140	——	150 V max	very low		very high

Fig. 4—Key characteristics of the various types of dielectric materials are listed above. Note that all have comparatively high resistivity and most have small dissipation factors.

Fig. 4 lists the four key characteristics for the six types of dielectrics we've examined so far. The figures come from the fourth edition of "Reference Data for Radio Engineers", but in most cases have been modified to cover an entire range of materials rather than specific dielectrics. (The plastics entry, for instance, condenses two pages of reference data into a single line covering the entire range.)

In general, the dielectrics with the larger dielectric constants are used more frequently at dc and low frequencies where larger capacitance values are more frequently needed. The critical factor so far as frequency is concerned is that of dissipation—this is a measure of internal losses, and dielectrics with excessive internal losses are not usable at higher frequencies.

For bypassing, for instance, either a paper or a mica capacitor can be used at low frequencies, but paper would be the more normal choice because of its higher dielectric constant. A physically smaller capacitor could be used, if paper were chosen. As frequency goes up, though, losses in paper increase more rapidly than do losses in mica—and at the same time the capacitance values required for effective bypassing go down. This makes the dielectric constant less important, and the preference would switch to mica somewhere in the neighborhood of 1 MHz.

The high-capacitance ceramic units, however, would be preferable to either so long as capacitance values of 0.1 mfd or less would suffice, since the unit would be smaller than an equivalent-capacitance paper unit, and would perform at least as well as mica up through the UHF spectrum!

In a tuned filter, on the other hand, the mica unit would be preferable in all cases. In a filter, the self-inductance of the capacitor would become an important factor, and that of a typical paper unit would vary widely from manufacturer to manufacturer because of differing construction techniques. All mica capacitors, however, are made in the same layer-cake fashion because mica is brittle, and so the variations would be held to a minimum.

How About Power Factor? Quite a ways back there, in looking at the low-pass R-C filter circuit of Fig. 3, we said that a load on this circuit would look like a resistor, unless the load had either inductance or capacitance—and we begged that question at the time. It's time for it now.

Obviously, any electric circuit could be put into a solid black box with nothing exposed except the terminals, and it would be rather difficult to tell what was inside.

When we're looking at the power circuitry of any device, we can forget all about the signal terminals and look only at the power terminals on that black box. Most of the time, we'll find that the innards of the box cannot be distinguished from a large resistor.

That is, if the gadget operates on dc, it takes both voltage and current, and replacing the black box with a resistor which draws the same current at the same voltage would put the same load on the power supply.

Sometimes, though, that resistor representing the circuit's power usage might appear to have a capacitor in parallel with it—or an inductor in series. If it draws heavy current when it's first connected, which comes down as time passes, that's the same action we would expect from a capacitor. On the other hand, if it draws less current at first than it does after it's been connected for a while, that's the action an inductor would produce. In the first case, we would call it a capacitive load, and in the second, an inductive load.

On a dc circuit, the inductance or capaci-

tance of the power loads is of little importance except at the instant of switching power on. When the power circuit uses ac, though, the inductance or capacitance appearing at the power terminals of a device can wreak havoc with other gadgets on the same line, because of the phase shift introduced on the main power lines by these reactances.

That's what "power factor" amounts to; it's just another way of measuring the apparent capacitance or inductance of a load on an ac power line. Any normal resistive load has a power factor of 0. This means that it is effectively a pure resistance to the power line, free of either inductance or capacitance.

A completely reactive load, having no real resistance in it but composed exclusively of either inductance or capacitance, would have a power factor of 1.0. If it were capacitive, it would be a *leading* power factor, and if it were inductive, the power factor would be said to be *lagging*.

In other words, the term "power factor" refers to the percentage of reactance in the load. The whole thing is almost identical to the "Q" factor we normally apply to coils and tuned circuits, but power engineers use the "power factor" approach instead.

Many "normal" devices used on ac lines have some reactance in them, which reflects to the power line as a power factor. Among these are electric motors, which reflect large inductive power factors when they are coasting, and are highly capacitive loads when power is first applied. The capacitive nature of the motor's load on the line is the reason most motor circuits use slow-blow fuses; these fuses will carry the "charging current" required by the reactive load without blowing, yet still provide protection if the current drain continues for an excessive length of time.

Transformers may reflect either inductive, resistive, or capacitive loads, depending upon the type of circuit connected to the secondary.

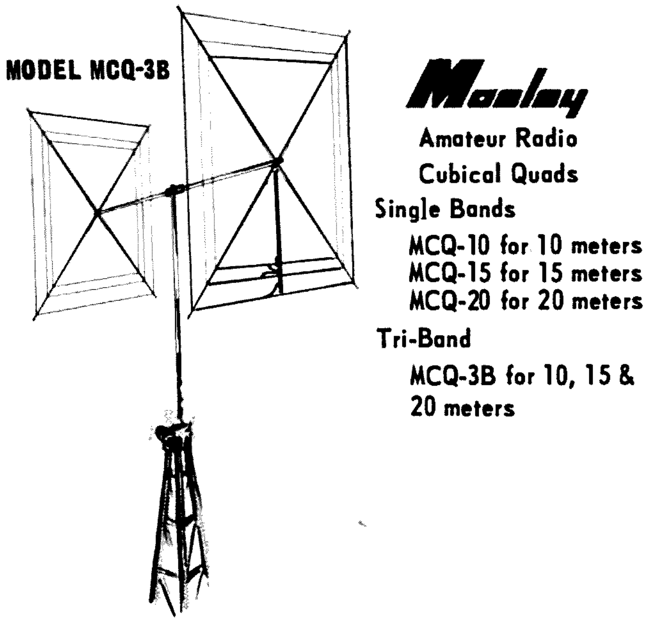
In general, power factors of any type of load can be corrected to the ideal 0.0 figure by deliberately introducing the opposite kind of reactance to cancel out that present in the load itself. For instance, "synchro motors" (commonly known as selsyms although this term is actually a trademark) usually appear to be inductive loads to their power sources. Correcting capacitors are connected across the lines supplying primary power to these devices, to "tune out" the power factor and keep the main power line itself at a power factor of 0. The amount of capacitance required to do this depends upon the power factor present in the load, which in turn depends upon the number of devices and their exact operation conditions.

In most ham power wiring, it's safe to assume that the power factor is always zero and not attempt to adjust it. Normal household wiring is quite tolerant of reactance, as are most devices used with it.

The term "power factor" is also used, in somewhat different surroundings, to describe the "dissipation factor" of a capacitor which we examined in the previous question. This usage, however, is not in reference to electric power circuits. When applied to a capacitor, the power factor is similar to the dissipation factor, and indicates the amount of loss to be expected within the capacitor at power-line frequencies. The higher the power factor, the greater the internal losses.

Next Session. The Extra Class exam is more loaded with theory than is any other amateur examination. While we're working with the basics and some of their finer points, let's stay with them a while longer and examine the details of amplifier operation. Even if you're not interested in the higher ticket, you may find it nice to know how an amplifier works! ■

NEW PRODUCTS



Mosley Amateur Radio Cubical Quads

Mosley's newly released MCQ Cubical Quad Antennas are available in single-band form for 10, 15, or 20 meters, or as a tri-band quad for all three bands. The antennas feature Mosley's rugged boom-to-mast mounting assembly with stainless steel clamps, 52 ohm coax feed to wire elements, and a Gamma Match coupling arrangement that maintains an SWR of 2.2:1 or better across the entire amateur band. Shipped with boom, spreaders, wire, hardware and instructions. For further data write to Mosley Electronics Inc.. 4610 N. Lindberg Blvd., Bridgeton, Missouri 63042.

TAB Book Catalog

If you're in ham radio as a game, or one of the electronics fields for life and advancement, there is a TAB book that you will be interested in. A recently published catalog describes over 100 current and forthcoming books, dealing with broadcasting, servicing, basic technology, electric motors, audio and hi-fi, test gear, transistors, and several other subjects. The catalog is available free upon request, from TAB BOOKS, Blue Ridge Summit, Pa. Ask for their 1968 catalog.

VHF Converter

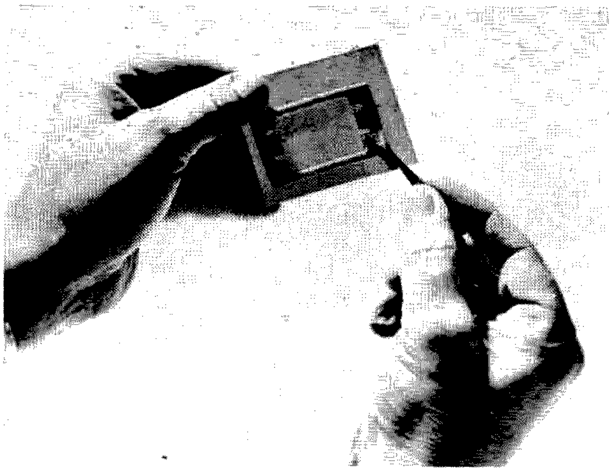
The performance of 1957's elaborate vacuum-tube receiving converters is considerably improved upon by today's inexpensive solid-state models. Prices are lower, too. For instance, here is a 432 MHz to 14 MHz converter, typical noise figure of 3.6 db., at a kit price of $29.95. Hams who have been around for a while will realize how remarkable this really is. The circuit requires about 4.5 mA from a 9 to 12 volt battery. Kit available from VHF Associates, PO Box 22135, Denver, Colorado 80222. Since they are an active company, you might ask for their catalog, too.

Varactor Multiplier

Sometimes it is easier to generate radio frequency power at a relatively low frequency, and then to use a simple circuit to generate a much higher frequency output. This possibility is a relatively new arrival in amateur electronics, using a key component now known as a varactor diode.

Varactor diode circuits can handle considerable amounts of power. For example, here is a varactor multiplier that will take up to 40 watts input on 144 MHz to generate about 24 watts output at 432 MHz. Unlike ordinary multipliers, varactors will take AM or sideband inputs as well as CW, without generating unacceptable distortion of the signal.

Several models are available. The one shown here, is priced at $54.95, from VHF Associates, PO Box 22135, Denver, Colorado 80222.

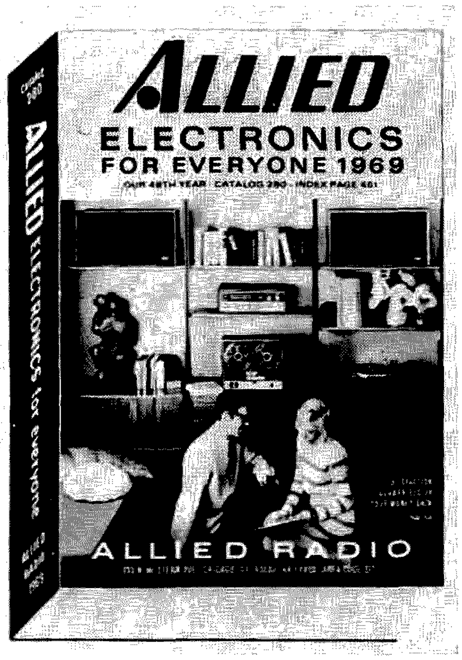


Metex Polastrip

If you are facing shielding or TVI problems, some modern ideas for interference shielding materials may interest you. For instance, how about POLASTRIP, a material provided with tiny wires in elastomer? Under pressure, the wires bite through dirt and oxides to complete connections between two parallel metal surfaces. If the POLASTRIP will not stay in place, you can ask for some POLASTICK. This is a special adhesive which will not interfere with the electrical properties of the strip material. For further information write to the Sales Manager, Metex Corporation, 970 New Durham Road, Edison, N.J. 08817.

Noise Suppressors

Mobile ham radio sounds like a lot of fun, but there are some hard technical problems to get over first. The car builders don't expect their buyers to have ears for electrical noise, but it turns out good ham radios are very sensitive, and respond strongly indeed to the electrical noises cars generate. Very often you can tell, without any technical knowledge at all, that your car is generating excessive noise, by hearing the noise change with the road or engine speed. Is there something you can find that will help stop this noise? Yes, and the Estes Engineering Co. is very active in this field. For a minimum job try their Ignition Suppression Kit #6415 at $8.95. Or for a more complete treatment their Universal Suppression Kit goes for $14.95 to reduce noise from spark plugs, distributor, generator, and other parts of the car. From Estes Engineering Co., 543 West 184 St., Gardena, Calif. 90247.



Allied 1969 Catalog

Allied Radio, perhaps the nation's largest consumer electronics distributor, has just published their #280 Electronics-for-Everyone, with 536 pages. This is a very large catalog, full of hi-fi gear, TV cameras and monitors, radios, phonographs and turntables, right through to test instruments, electronics components, and a line of kits. This line includes Allied's recently introduced KG-2100 Triggered Sweep Scope kit, and a variety of other test instruments. For all these details, the catalog is free on request from Allied Radio Corporation, PO Box 4398, Chicago, Ill. 60680.

Model 830 Transistor Commander

Weight: 3 lbs. Portable. Luggage type case is 9¼" x 6¾" x 6⅜". That's Amphenol's new service oriented transistor tester. It can also check diodes, zeners, and circuit supply voltages up to 100 volts.

Provided with color-coded meter scales for simplified tests, the Model 830 tester will measure the DC beta of small-signal or power transistors without their removal from the circuit. Out-of-circuit tests include I_{CBO} measurement. The tester is protected against accidental burn-out of transistors and diodes, or of the instrument itself.

Available from Amphenol Distributor Division, 2875 South 25th Ave., Broadview, Ill. 60153. Price, $79.95 net.

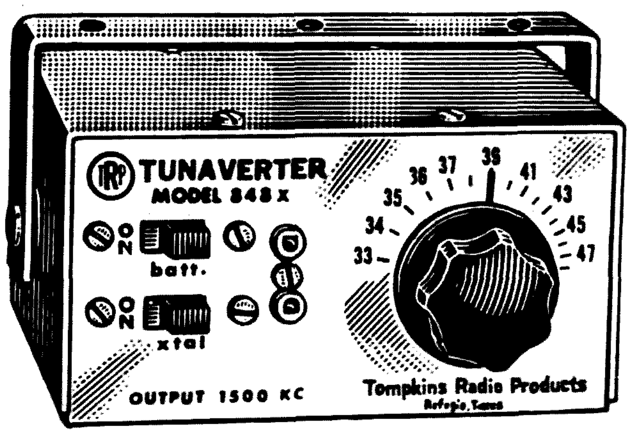
Semiconductor Handbook

Semiconductor Handbook, by Robert Tomer. From Howard B. Sams & Co. Inc., 1968

The good old days of small transistor handbooks are long past, but a coverage of the general principles along with illustrative applications can still be packed nicely between two covers that are not too far apart.

It takes 13 chapters and three appendices to do the job, but the field is covered from basic physics ideas through circuit fundamentals, component ratings, industrial and power applications, communications applications, advanced devices in general, FET's in some detail, and at last about 20 pages on micro-circuits and integrated circuits.

The coverage is improved by many small diagrams, located at frequent intervals through the text where they are handy to the appropriate paragraphs. This is a second edition, written by an experienced field engineer. His experience shows in the close relevance of the writing to readers' requirements. From Howard B. Sams & Co., Inc., $5.75.



RF Converter

Tompkins Radio Products has developed new models versatile *rf* converter line. Their new TUNAVERTER X line can tune over a range of frequencies, and then monitor drift free with crystal control by simply flipping a switch. Another channel may be monitored by changing crystals. Priced at $32.95 each less crystal from Tompkins' marketing division, Herbert Salch & Co., Woodsboro 73M, Texas 78393.

Dictionary of Electronic Terms

If you have not been working in electronics for very long, or if you have, for that matter, sometimes you need to find out what some new term means. A remarkably complete collection of old and new terms has just appeared on the market.

Allied's dictionary supplies definitions of power line, coil form, Citizens' Band radio, radio receiver, etc., which will be very useful to the beginner who wants to understand what the basics are all about.

But like any complete dictionary, it also meets requirements for the advanced worker. For instance, what is a ferrospinel? Triad? (a color TV term) or how about gamma ferric oxide?

The print in this 112-page dictionary is a bit small, but it is a good visible type face, offering a lot of material between two low-priced covers. A really complete book, and the definitions are not too short to be useful. From Allied Radio Corporation, Chicago, Ill., and the price is a remarkable one dollar.

Application Notes Catalog

If you're thinking about that next project, or the one following, maybe you can find some ideas in Motorola's new Application Notes Catalog. It is industrially oriented, but many of the entries should be interesting to non-engineers and amateurs. There are 130 entries, each describing the design and application of a circuit (or circuits), using Motorola components. A Selector Guide section at the beginning of the catalog lists the entries by applications categories.

Titles include "20 Watts at 1 GHz with Step Recovery Varactors," "An Integrated Circuit RF-IF Amplifier," "Using Shift Registers as Pulse Delay Networks," and "Unijunction Transistor Timers and Oscillators." Several reference guides, two catalogs, and the Semiconductor Data Book are also listed, in the back of the catalog.

For your copy of this handy guide, the Motorola Application Note Catalog, write Department TIC, Motorola Semiconductor Products Inc., Box 20924, Phoenix, Arizona 85036.

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Long Beach, Calif. 90803

Is it Cold Down There?

A common query when the men on the "ice" at McMurdo Station in the Antarctic receive phone patch calls from home. Invariably the answer is "It's always cold and the temperatures are below zero in summer or winter."

Phone patching and teletype traffic to the Antarctic stations is a *must* every day of the year, band conditions permitting. The morale of the men depends on the communication link with their loved ones. The isolation in this remote part of the world is easier to take knowing there are dedicated radio amateurs ready at all times to serve them.

In former years the phone patching and traffic handling was done by any stations that would oblige in meeting schedules with KC4USV, McMurdo Station. However on May 11th, 1967 a new Navy MARS net began operations and now has a membership of thirty-seven stations that represent coverage of every part of the United States. Appropriately the net control station at McMurdo was assigned the Navy MARS call NØICE.

Operator at NØICE/KC4USV at McMurdo Station running a phone patch through the Navy MARS Antarctic Network. Official Navy photograph.

With the transition to Navy MARS, the Antarctic Network has become more effective in the handling of phone patches and teletype messages. In the first year of operation, the net handled 3,536 phone patches and 287 messages from McMurdo. Since April of this year, 2,433 phone patches and 2,503 messages have been completed and by the end of this year these figures will far exceed the totals of last year. During the winter over period (March to September) most of the teletype messages are of one hundred word personal letter text as mail service is non-existent during the Antarctic winter season. Also phone patches are not limited to five minutes due to the isolation of the men and the net is tailored for their welfare.

Operations on the net begin each night on the east coast at approximately 0100 GMT, the midwest at 0300 and the west coast at 0430 GMT on the Navy MARS frequency of 13,975.5 MHz. To expedite the handling of phone patch calls, numbers are assigned to the families of the men stationed at McMurdo. Each net member has a copy of these numbers with the name of the party to call, town or city and phone number. The net control need only pass the number to the net station for the phone patch call. At times there may be as many as ten to fifteen calls placed with some of the net stations to complete in his or her area.

In the summer season, September to February, the population increases at McMurdo Station with the arrival of the scientists and more military men. During this period, traffic to the states is at it's peak and sometimes it is necessary for the net to work around the clock, especially on Christmas and Mother's Day. Usually the net control station at McMurdo has several operators working in shifts and the net stations frequently have extra operators to man their stations. With McMurdo Station as the communications center for the outpost stations (South Pole, Byrd, Palmer and Plateau) this also adds to the traffic load.

The members of the Navy MARS Antarctic Net not only handle the phone patches and messages but in many cases shop for gifts

at Christmas, weddings, anniversaries and birthdays for the men in the Antarctic and have them delivered to their families. Such service by the net members are not forgotten and when the men return to the United States they make personal visits to these members to thank them for this service.

Recently during the operations of Project Facsimile Antarctic[1] the net was used as the liaison frequency between McMurdo and southern California. This was arranged for by Chief Navy MARS and assistance was given by MARS Director, Lloyd Madison of the 11th Naval District and MARS Director Terry Swartz who succeeded him. The net manager, Kenneth Nokes, NØRYE, arranged the operations schedules with the facsimile operators at McMurdo Station and thru the several months of the facsimile project did help to keep things operating smoothly on the net while transmissions of pictures were beamed to McMurdo.

Words of praise are offered to the net members of the Navy MARS Antarctic Net for their continued efforts to keep up the morale of our servicemen who do duty in remote parts of our world. The net roster lists the following stations associated with the Antarctic Net: NØAAJ, NØAJN, NØAOO, NØAYT, NØEJH, NØEQH, NØEQZ, NØEYX, NØFMO, NØFPG, NØFQP, NØFXQ, NØHFO, NØIDH, NØIFH, NØILN, NØIMK, NØITS, NØJBF, NØJRT, NØJVG, NØKMR, NØKWS, NØRLX, NØRTR, NØRUH, NØRWL, NØRYE, NØUSM, NØVAE, NØVQJ, NØWCK, NØWNN, NØXRO, NØYNK, NØYQJ, NØZFF, NØZHP, NAV 8 and NAV 11.

The contribution and dedication of these Navy MARS members can be expressed by the following letter addressed to the net manager, Kenneth Nokes, NØRYE, from Chief Navy MARS, LCDR. Robert E. Mickley:

"I would like to take this opportunity to express my appreciation to you and your fellow Navy MARS Antarctic Network members regarding the accomplishments of your operations during the wintering-over period.

Through you untiring efforts and those of your associates, you have succeeded in breaching the communication gap between personnel serving their country in the bleak Antarctic wastelands and their families and friends in the United States.

The record messages, radiotelephone calls and radio-teletypewriter letters handled by the Navy MARS Antarctic Network provided an outstanding service and exhibited a high degree of communication readiness. This accomplishment has brought significant acclaim to yourselves as individuals and to Navy MARS specialty operations.

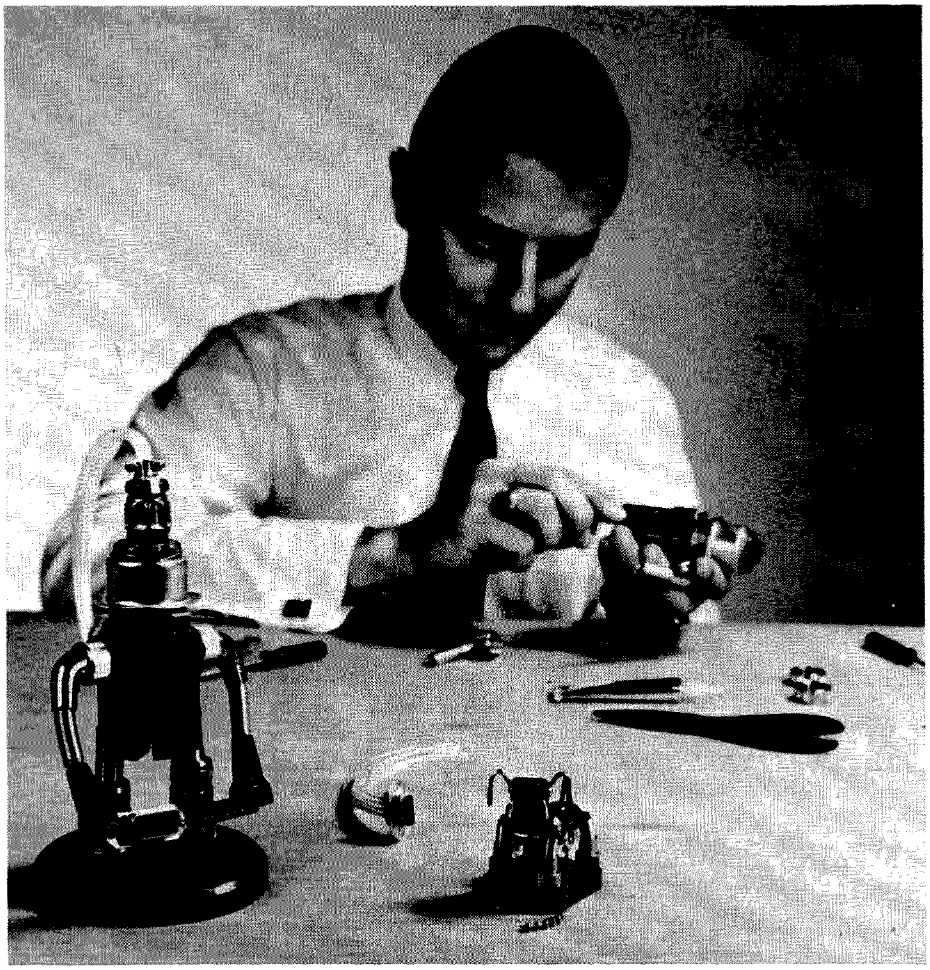
Please express my appreciation to the members of network for a task "Well Done."

. . . K6GKX.

References

1 . . . 73 Magazine, November issue, 1968, Page 86.

Creative Interconnections: the "Ampheham"



John Gove, product specialist for Amphenol Industrial Division of The Bunker-Ramo Corporation, Chicago, is shown above constructing a new "Ampheham," which, when completed, will look identical to the five-inch-high mechanical ham shown in lower left-hand corner. The Ampheham is constructed almost entirely of those types of microphone connectors, power connectors and tube sockets found in most hamshacks, manufactured by the division. The "amateur's" body, only exception to this rule, consists of a high-wattage prejector lamp socket, also made by Amphenol. A close look at the photograph also reveals John's "Amphepup" (foreground), a tiny dog fashioned from miniature-type Amphenol microphone connectors and tube sockets.

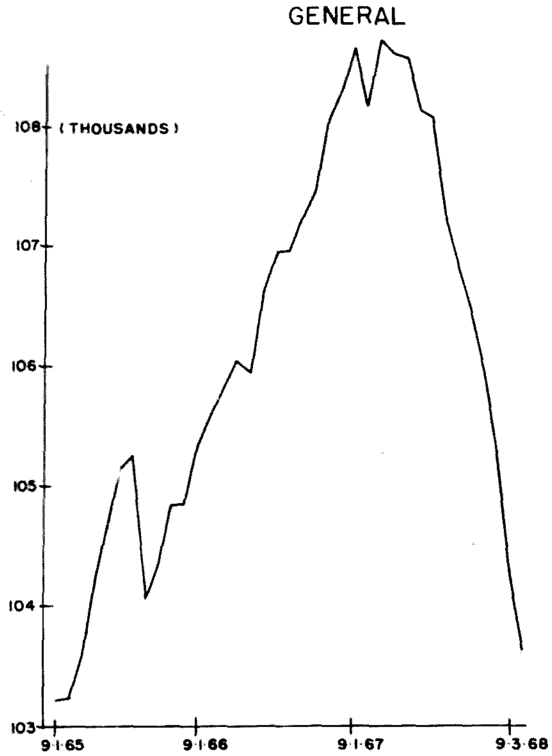
Incidentally, John's craftsmanship can also be seen on our December cover (the Amphepup and colorful, specially-designed "Ampheclaus"). ■

(...de W2NSD/1, continued from page 4)
mercial" to many amateurs. The widely reported failures at passing the Extra exam (possibly around 50%) also have tended to discourage fellows from taking the time and expense of trying for it.

Up until 1968 the Advanced Class license was closed to newcomers and we see the gradual drop off in licensees as cigarette cancer and apathy ate into the ranks. It was dropping off about 1000 a year or so. Then, when the license was opened again last year, in trooped the troops. About 5000 new Advanced Class licenses were issued.

Considering that the most choice twenty-meter phone frequencies are now restricted to Advanced and Extra Class licensees, the number of new licenses is piddling.

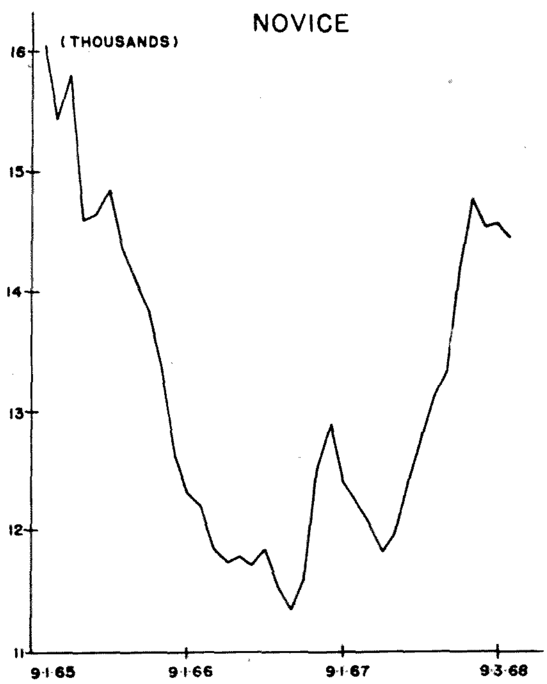
Most of the new Advanced and Extra came up from the General Class license, as we can



see from the graph. There is a loss there of about 5000, pretty much the same number that turned up in the Advanced category. 5000 out of 108,000 Generals is not exactly a tumult. It is more like a 4.6% response. Less than one in twenty! Perhaps this helps to explain the enormous vacuums in the new Extra in Advanced Class band segments.

This class of license has been dropping off ever since the FCC rewrote the rules and virtually did away with the class. Now, as renewals come up, the old Conditionals either drop out or become Generals. As you can

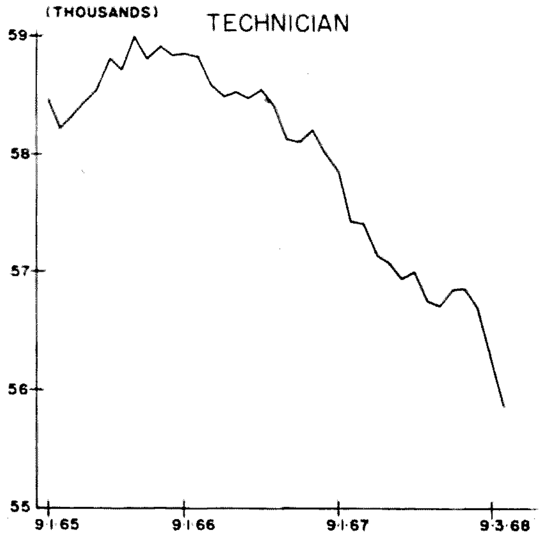
see, the incentive deal did not change the picture in the slightest. There is not any indication whatever of the Conditionals going for a higher license.



The interest of the newcomers reached bottom a couple of years ago and now is building up again. We really should make a major effort to get more and better hams into our hobby through a program of public relations.

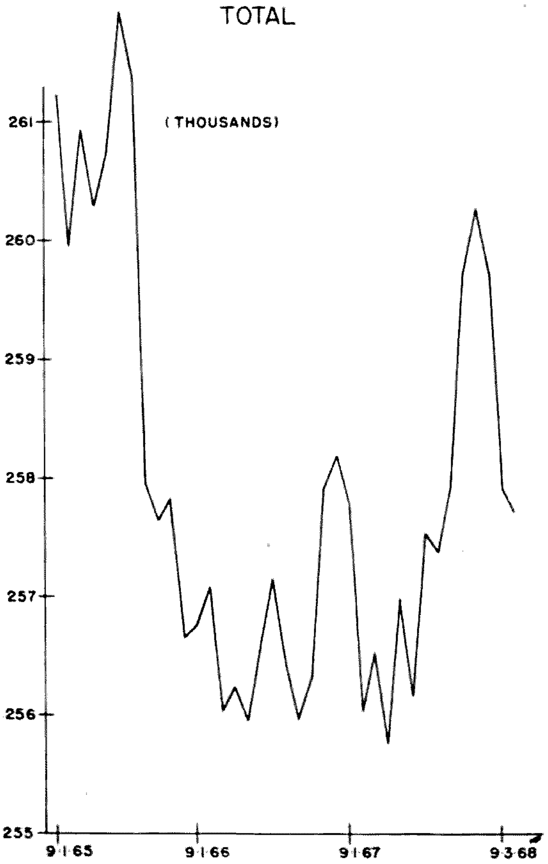
The drop-off has been steady for the last

two years. 2½% a year is not a reason to panic, but just the same I'd be interested in any ideas on where the Techs have gone.



That large drop-off in 1966 is probably more of a computer correction than a real change in licenses. In the last two years the number of hams has been very slowly growing, perhaps averaging out at about a thousand a year. It certainly isn't much like the good old days when our ranks were growing at about 10% a year! Perhaps we need new management?

Perhaps we should recognize that whether



we approve of the new regulations or not is besides the point now. They are the law and apparently will remain the law for some time to come. Our job now is to fall into line and get our higher class license as soon as we can. It is the responsibility of the ham magazines to make the transition as easy as possible. It is the responsibility of the radio clubs to encourage and assist members in getting their new licenses. We at 73 are doing everything we can think of to make it simple to pass the new exams.

Hamfests and Conventions

Hamfests and conventions, despite what you may have read recently, can be a ball and I try not to miss any more than I have to. During the last year I managed to get to the Long Island Hamfest, the Swampscott Convention, the National in San Antonio, the Saroc in Las Vegas, the Sideband in New York, the VHF in New Jersey and the Rochester Hamfest. Kayla managed to get to a lot that I had to miss, such as the Dayton Hamvention and many others.

Perhaps I should also count the 73 Hamfest up here in July. We didn't outpull the ARRL National as we did back in 1965, when we ran our last hamfest, but we did have quite a crowd and we had a lot of fun. I suspect that Hemisfair was more of an attraction than New Hampshire and its mountains. I enjoy New Hampshire a lot, but I do have to admit that I had a whale of a good time at Hemisfair and I'm glad I went.

Hamfests and conventions are important, I feel, to the spirit of amateur radio. Here we can all get together with the top hams of the country who are there demonstrating ham-TV or slow scan TV, ham-RTTY, ham facsimile, moonbouncing and all of the other special interests that go to make up our hobby of ham radio. A good convention will keep you hopping from one interesting session to the next.

How many contests have you entered at a hamfest? Code speed contests are simple to put on and are fun. Mobile operating contests are simple too. Fox hunting is great—it is the primary amateur radio activity for thousands of amateurs in Russia and several iron curtain countries. And how about working up some special contests, say perhaps one for the phone men with twenty telephones connected in parallel and a given time for all to exchange short messages or even just call letters with as many as possible. They will be yelling their heads off, if it works out any-

thing like a DX pile-up. I'm sure that an enthusiastic hamfest committee will be able to work out a number of events that will make their hamfest memorable—and will bring back even more the next year.

If the committee coddles the speakers they will get them back again too. All too often a guest speaker is left to just stand around until his speaking time comes. Some committees make sure that speakers are welcomed. The Swampscott committee puts on a special dinner for them, gives them badges and makes them feel glad they came.

Most hamfests don't rely too much on exhibitors as a drawing card for their hamfest, but convention committees know that the exhibits can make or break a convention. Every manufacturer in the ham field gets letters constantly asking him to come and exhibit at this or that convention. Some letters give the impression that the convention is doing the manufacturer a big favor by letting him display his wares. I realize that a good many amateurs have a basic feeling that everything in ham radio should be entirely home made and that manufacturers are an unnecessary evil. Without our manufacturers I fear that much of ham radio would still be hung up in the Tri-Tet Crystal Oscillator days and running 200 watts to a 6L6.

I get to talk with most of the manufacturers in our field and I think I know all of them pretty well. The best of them may be making a profit of 10% on his ham sales. That is, unfortunately, the exception. This means that any additional expenditure that he makes must be able to bring in ten times that expense in sales volume. A $100 magazine ad must bring in $1000 in sales. A convention booth must bring in $10,000 in sales just to break even, at the least. By the time you add the cost of the booth space, shipping the exhibit from the factory and back, plane fare, hotel, and etc., it costs more like $2000 for a convention.

How valuable is a convention to the manufacturer? Well, if you figure that he can talk to about two or three hundred prospective customers during the show, he has to do a powerful lot of selling to make it profitable. The average affair runs for about eight hours on two days, a total of 960 minutes. One customer every three minutes would total 320

Are there solutions to these problems? Of course. The convention committees that organize their club members to help make life easy for the exhibitors will find that they have a lot more displays. Show them the town, buy them a dinner, help them set up and pack their displays, offer them accommodations in members' homes. Spell them at their booth so they can see the convention, attend some of the talks, and get a snack. Most manufacturers have an interesting story to tell about their product and you could do worse than offer them a little time in front of an audience to talk and answer questions.

The secrets of putting on good conventions have been pretty well worked out. Hamfest and convention chairmen could do a lot worse than get in touch with the fellows who manage the Swampscott and Dayton conventions every year. These are the two most successful conventions year after year because they are well planned and are fun.

Lots of Prizes

There is much to be said for displaying all of the prizes prominently, complete with a commercial message beside each product. The winners can then come up and pick their own choice of a prize. This matches the needs of the winners to the prizes available and helps to cut down the discount selling of unwanted prizes after the hamfest, a process which is distressing to both the prize winners and the manufacturers.

Perhaps some publicity in the hamfest program could be given to the prizes. Also, as the prizes are picked out by the winners the announcer could read off the commercial message. If you show the manufacturer that it is to his advantage to give prizes for hamfests, there will be a flood of prizes.

Letters to the Editor

When I visit ham clubs I get asked a lot of good questions about ham radio, the ARRL, Don Miller, CQ, Incentive Licensing, the ITU, the IARU and other matters of general interest. The club members tell me that they enjoy knowing more about these things. Yet we hardly ever get any letters here at 73 asking about these things.

Yon might keep in mind, when you read something rotten about 73 elsewhere, that other publishers have a very good reason for hating us. 73, as far as we know, is the only ham magazine that is in the black. It will take more than name calling and cover immitating to change the pattern.

While I don't put much stock in editorials in other magazines calling me a scoundrel, you may and perhaps you feel that there are some questions that need answering. Ask away and we'll bring out the true facts.

Let's see them cards and letters, folks.

Carole H. Allen W5NQQ
308 *Karen Drive*
Lafayette, La. 70501

Be a Good Ham and Not a Bad Egg!

The mailman just delivered a small white envelope from the Federal Communications Commission and at last you're a ham radio operator! As you open the envelope and see your call letters for the first time, you join thousands of other hams in a new world of adventure. And, of course, dozens of these amateurs are probably right in your own hometown or area. If you want to enjoy the hobby to the fullest and form the most lasting friendships, resolve right now to be a good ham and not a bad egg!

Make a few rules for yourself about borrowing and loaning—and stick to them! It may seem a trivial subject but you'd be surprised how serious it can be.

For instance, imagine what happens to a budding friendship between two hams if one borrows an expensive tube tester from the other and then returns it several weeks later not working properly. Or what if the ham down the street says he desperately needs your jin pole to put up an antenna that weekend but lets it lie in his yard long enough to rust before bringing it back!

Oh, you'd never do anything like that, but who would have thought these fellows would either? They probably wouldn't dream of borrowing your car, camera, or lawn mower, but when it comes to ham radio, anything seems to go. Some hams feel that since we're all members of a great fraternity, they want to make sure they get the most from their memberships!

But what can you do about people who borrow? Of course, you can refuse to loan anything at any time and quickly become known as a sorehead. Yes, you may always have your possessions at hand, but you'll make it almost impossible to ever borrow anything yourself no matter how great your own emergency.

There are a few other tactics that are worth a try. In the first place, don't borrow anything yourself if you can possibly avoid it. You really ought to own a soldering iron, screwdrivers, wrenches and an assortment of nuts and washers, so don't pester some other fellow for these items. You'll be asking for return requests.

And if you want to look over a schematic in a current issue of an electronics magazine, for heaven's sake, cough up the 75 cents and buy it on the newsstand. Let the guy who subscribed to the magazine keep it on his desk. If you find you must borrow a back issue of a magazine, make a copy of what you're interested in and return it before the sun sets.

If you need an ohmmeter, voltmeter or equipment that will be beyond your budget for a long time to come, try to use it at the owner's home. Call him first and make sure you're welcome. If you're checking out a cumbersome kilowatt rig or something else extremely hard to move, ask the owner of the test gear if he would have time to come over and help you with the measurements. Chances are he would be tickled pink to bring his equipment and help you solve the problem right in your hamshack. This way there is no doubt how his property is handled and you'll probably learn a lot in the process.

If you do borrow a tube tester or anything else, don't ask for it until you're ready to use it, and then return it immediately. If you're delayed and can't take it back when you said you would, call the owner and tell him. Don't just keep it indefinitely. This is a sure way to make an enemy.

And another important rule of the game—don't ever loan anything you have borrowed to anyone else! It just isn't yours to loan; and believe me, if something is going to be

damaged or lost, it will happen when you have reloaned it. Then you really are in a pickle—you're still responsible for the borrowed article and you must explain that you had loaned it to someone else!

But what is the worst should happen while you're checking out your mobile rig with Tom's grid dipper and you drop it on the concrete driveway. Replace the dipper or fix it but don't returned a damaged article. If you take the broken dipper back as it is, the owner may say, "Oh, there probably isn't too much wrong with it," while gnashing his teeth, or he might give you a black eye.

If you have an accident with a borrowed item, even if an old tube flickers out, fix it first and then return it with explanation and apology.

On the other side of the coin, you'll be asked to loan things too. Put your name and call letters on a small tag and fasten it to tools or other items that might easily get lost in someone else's garage or shack. Label your magazines with your call letters and this will serve as a good reminder to the borrower that you want them back. There may be a lot of people you will loan to freely, but if you're approached by someone with a reputation for misusing borrowed gear, you can insist on accompanying whatever he borrows and then bringing it right back home. Or you can tell the little white lie that you just happen to be using what the fellow wants to borrow and just can't let it go.

After you have been on the air for several years, you will have scrimped, saved, and accumulated a fine inventory of test equipment and tools for your shack that will make a beginner blink with envy. He may have nothing more at home than a homebuilt CW rig and an imported key and you will be the first person he thinks of when needing to borrow something. No one objects to loaning equipment or tools to a beginner who needs a boost, but everyone's personal goal should be to accumulate what he or she needs to operate his equipment independent of another fellow. After all, John Smith saved his pennies for that $75.00 safety belt so if a sudden wind blows a limb across his beam antenna 80 foot up on a tower in his back yard, he can take care of it immediately. He didn't buy it for someone else to borrow and stack in his closet for a month or two.

The Golden Rule is just as applicable in ham radio as anywhere else. If you absolutely must borrow something, treat it as you do your own property and don't keep it one minute longer than necessary.

If you follow these suggestions carefully you'll never have to worry about being a bad egg—you'll be known by your friends as a real good ham!

. . . W5NQQ

73 Visits the Federal Aviation Control Center at Nashua N.H.

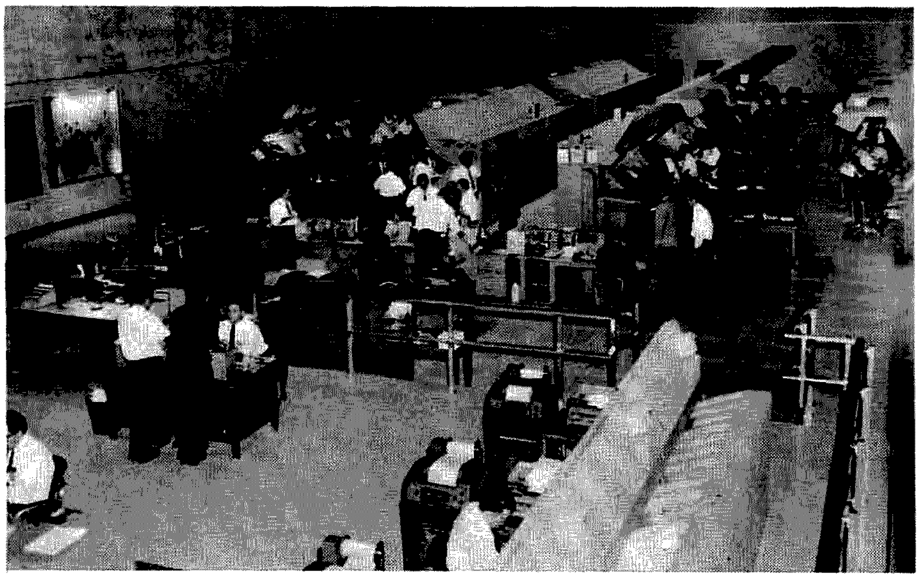
What are radio amateurs doing in the world of modern technology? One prominent public service business is air travel, and as we think about airplanes and public transportation we may remember a time, maybe thirty years ago, when airplanes were known human accomplishments but you did not see one very often.

A real, loud, amazing, *two-engine* airplane could upset anybody's schedule, if it passed over low enough. Some of them did. We all knew these were built and flown by men, but the thought of actually entering one and going up in the *air* with it seemed very unlikely.

I recall some magazine stories about Stratoliners, and it was believed that someday commercial flights at altitudes as high as 20,000 feet might be practical. This, men thought would be well above most atmospheric disturbances, and air travel would be very comfortable. That was in the days before jet engines, radar sets, and Clear Air Turbulence. Since then I have flown in passenger aircraft as high as 40,000 feet, and experienced the curious sensation of somebody hitting the plane with big soft hammers. Looking out the window I have seen other planes traveling with tremendous velocity in the opposite direction, and I have sat watching the wing (whose tip I could not see) while the pilot worked his way down through a stack in zero visibility, to land at last in a snowstorm.

Electronics in Air Travel

When you consider the problems, you may feel some surprise at the relative ease and reliability exhibited by airliners departing for some distant point, and getting there. The worst difficulties seem to be on the ground, getting to the airport, and from there to your destination. Some newspaper reports appear about those flights that don't make it, but think for a moment-there is an awful lot of air traffic. If all the successful trips were reported in any detail at all the newspapers could not publish very much



A general view of the many electronics consoles where flight controllers are observing and tracking aircraft.

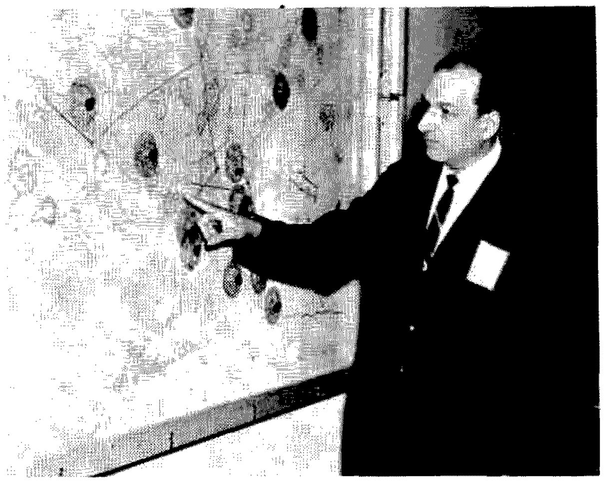
Looking at some of the more complex electronics gear. This is a system that adds maps to the radar display, and transmits the appropriate part of the resulting image to one of the radar repeated consoles.

else. Air travel has its hazards, but on the average it is a safe and very fast way to make long trips. If you avoid bad weather and those times when many other people are traveling you can get from New York City to San Francisco more comfortably than you can make a 300-mile bus journey, and, in about the same time. The air travel business has become a remarkable, huge industry.

A key part of this industry is electronics, appearing as data processing, telephone and radio communications, and radar observation and mapping. Are there radio amateurs in this work? Why not look for radio amateurs at the nearby Air Traffic Control Center? We came up with the name of Eli Nannis, W1HKG, and after a telephone call I went up for a visit. I expected to find something like a control tower or other conservative if slightly odd airport-type structure.

The Boston Air Route Traffic Control Center

A bit of careful navigation (following road signs) brought me to the Center. Isn't



Eli Nannis, W1HKG, is pointing out some of the characteristics of the New England area.

that odd? No airport, I thought. Seems to be no airport anywhere near here. Just this big block of a building with a microwave tower nearby, and some dipoles or longwire antennas. Looks like a manufacturing plant of some kind.

Walking up to this building, I rang the buzzer and shortly Eli Nannis came to the door. Going inside we walked down a short corridor and into a large room. It was more than that: it was a *huge* room! I was appalled. I was going to write something about this? Seeing that I might be approaching a state of shock, Eli considerably conducted me along one wall (I felt like a mouse invading an auditorium) and we went into the Center's amateur station, WA1HOB

It turned out the Center has a rather large and quite active ham radio club. There are hams from all parts of the Center, which employs about 400 people and is in business 24 hours per day, every day. The ham station consists of a Galaxy transceiver, some test gear, and of course an SWR bridge. The setup there can be operated from mains power, the Center's emergency power, or from car batteries, and can double over for emergency communications if necessary. An educational program is continuing for the improvement of hams' technical and communications backgrounds, and several new amateurs are expected to receive their tickets shortly.

After we visited the station, and I had recovered slightly from my shock at seeing the size and complexity of the Center, we discussed the work that is done there. Basic-

ally, its purpose is to oversee all air traffic, except a few light planes, within the area between northern Maine south nearly to New York City, and west to slightly beyond Syracuse. Air traffic within five miles or so is controlled from the airport control towers, and is not a responsibility of the Center.

There are four technical areas in the Center, reflecting the four general kinds of work carried on there. They are communications, display preparation, data processing, and the flight control area.

I was very surprised to find the Center has no radar or other direct connections with the outside world of air traffic. All radio gear and radar systems used by the Center are situated at appropriate places over the control area, and linked to the Center by microwave or telephone systems. For instance, a flight controller handling traffic near Syracuse uses a radar display that is generated at Syracuse, not in New Hampshire. Since any controller can talk with as well as observe any plane in his area, and there are many areas and controllers, the Center has a communications system that certainly appears large enough for a fair-sized town.

The equipment that generates the displays used by the flight controllers is on the same lower level as the communications system. Several large cabinets contain some rather unusual gear that combines incoming and locally generated displays, and prepares them for use by the controllers on the floor above.

At one end of the building, on a large raised platform, there is a large Univac computer. It is to be replaced by a larger

Here Eli Nannis is following an aircraft on one of the many radar repeater consoles.

one, I understand, within a year or two since it is having some difficulty keeping up with the work. This computer prepares flight information by use for the controllers, and reads it out on the machines visible in the lower RH corner of the large photo. This computer can accept information from other computers in adjacent flight control zones, without human assistance, so that controllers are promptly informed of flights entering their areas or passing over on long trips.

And at the other end is the actual flight control area, consisting of many small consoles, each manned by a group of two or three workers. The consoles at the left hand side of the room are operated by men controlling flights above 20,000 feet, and those on the right are for flights below 20,000 feet. Each console displays only a rather small part of the overall picture of the entire area.

How the Center Works

All commercial and military pilots, and many private pilots, file flight plans with the FAA shortly before takeoff. These list takeoff and landing times and places, and proposed schedule in flight. Fed to the Center's computer, these figures are checked against other flight plans, and changed if necessary to avoid hazardous interference possibilities. Finally, the computer prints out information slips for the flight controllers, carrying the data each one needs to follow that flight across his screen.

The controller sees the plane as a blip on his screen. He notes the plane's designation, bearing, speed and altitude on a small piece of plastic (called a shrimp boat) which he pushes across the radar display to follow the appropriate blip. If he wants to talk with the pilot he is able to communicate through the elaborate phone and radio system, and can ask the pilot to activate a transponder in the plane. This generates a brief but prominent change in the blip, and the test is regarded as most successful if the appropriate blip flashes, and most needed if some other blip flashes. Positive identification is made very quickly in this way.

Each controller is responsible for the safe flight of up to ten (or 20, in emergencies) aircraft across his area. He gets about sixteen months of training, on special simulated displays, before he goes to work as a controller.

As Eli was explaining this to me, something was gaining my attention. I looked at one of the displays close up and finally it struck home: These looked like PPI displays, and they were green as you would expect, but they seemed to show TV scanning lines. In fact, they appeared to be TV displays, not radar displays. I asked Eli about this. What was the purpose of it?

Some Very Practical Electronics

That explanation took some time, and we visited some parts of the building again as the various parts and functions fell into a clearer picture.

The incoming radar displays are not very good for flight control work. For instance, beacon sites and airways are simply places on the map and there is little or nothing to serve as accurate reference for radar navigation control. Airways do not reflect radar waves. And so the map is added at the Center. A flying spot scanner does that job.

A sharply focussed spot moves across the face of a fast-phosphor tube (the trace is quite blue, almost violet) in synchronism with the radar trace. A map is placed over this display. Since the map is drawn on transparent material, its lines appear as positive or negative lines when added to the incoming radar picture. Very little electronics is required to do this job, most of it serving to keep the flying spot trace and the map in synchronosm with the radar display. The combined signals are presented on the face of a special image memory tube, but this picture is off-center so that only a portion of the area visible to a given radar set appears on the memory tube phosphor.

This is because the same big display can be fed to several memory tubes simultaneously, each tube getting an area that is interesting to one flight controller. A TV pickup tube assembly then reads off the image for use in one or more flight control consoles. Since there are several of these systems, a data processing system, and many communications systems, it is evident there is a lot of electronics installed in the BARTCC.

The Future

Hams thinking about their future in electronics should be very interested in the FAA's work in aircraft safety and navigation. The field is rapidly developing in complexity and sophistication, and although it's pretty elaborate right now it was my impression that you'd really be getting in on the ground floor. Right now, electronics technicians get about $9,000 worth of training over a period of six months before they are qualified, and this can be expected to be worth more and take longer as proposed new gear and systems are installed and made operational. ■

Propagation Chart

FEBRUARY 1969

ISSUED DECEMBER 1

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	7	7	7A	14A	21A	21A
ARGENTINA	14	7A	7	7	7	7	14A	21	21	21	21A	21A
AUSTRALIA	21A	14	7B	7B	7B	7B	7B	14B	14B	14	21	21A
CANAL ZONE	14	14	7	7	7	7	14	21A	28	28	21A	21
ENGLAND	7	7	7	7	7	7	14	21A	21A	21	7A	7
HAWAII	21	14	7B	7	7	7	7	7B	14	21A	21A	21A
INDIA	7	7	7B	7B	7B	7B	14	14	7B	7B	7B	7
JAPAN	14	7A	7B	7B	7	7	7	7B	7B	7B	7B	14
MEXICO	14A	14	7	7	7	7	7	14A	21A	21A	21A	21
PHILIPPINES	14	7A	7B	7B	7B	7B	7	7B	7B	7B	7B	7B
PUERTO RICO	14	7	7	7	7	7	14	21A	21A	21	21	21
SOUTH AFRICA	14	7	7	7	7B	14	21A	21A	21A	21	21	14
U. S. S. R.	7	7	7	7	7	7B	14A	21	14	7B	7B	7
WEST COAST	21	14	7	7	7	7	7	14	21A	21A	28	21A

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	7	7	7	14A	21A	21A
ARGENTINA	21	14	7	7	7	7	14	21	21	21	21A	21A
AUSTRALIA	21A	14	14	7B	7B	7B	7B	7B	14	14	21	21A
CANAL ZONE	21	14	7	7	7	7	7A	14A	21A	28	28	21A
ENGLAND	7	7	7	7	7	7	7B	14	21A	14	7A	7
HAWAII	21A	14	7B	7	7	7	7	7	14	21A	21A	21A
INDIA	7B	7B	7B	7B	7B	7B	7B	7	7	7B	7B	7B
JAPAN	21	14	7B	7B	7	7	7	7	7	7B	7B	14
MEXICO	14	7A	7	7	7	7	7	7A	21	21	21	21
PHILIPPINES	21	14	7B	7B	7B	7B	7	7	7	7B	7B	14
PUERTO RICO	14A	14	7	7	7	7	14	21A	21A	21A	21A	21
SOUTH AFRICA	14	7	7	7B	7B	7B	7A	14A	21A	21A	21	14
U. S. S. R.	7B	7	7	7	7	7B	7B	14	14	7B	7B	7B

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	3A	3A	3A	3A	3A	7	14	21	21A
ARGENTINA	21A	14	14	7	7	7	7	14	21	21	21	21A
AUSTRALIA	28	21A	14	14	7	7	7	7	14	14	21	21A
CANAL ZONE	21	14	7	7	7	7	7	14	21A	21A	21A	21A
ENGLAND	7B	7	7	7	7	7	7B	7B	14	14	7B	7B
HAWAII	28	21	14	7	7	7	7	7	14	21A	28	28
INDIA	7B	14	7B	7B	7B	7B	7B	7	7	7	7B	7B
JAPAN	21A	21	14	7B	7	7	7	7	7	7B	7B	14
MEXICO	14A	14	7	7	7	7	7	7A	21A	21A	21A	21
PHILIPPINES	21A	21	14	7B	7B	7B	7	7	7	7B	7B	14
PUERTO RICO	21	14	7	7	7	7	7	14	21	21A	21A	21A
SOUTH AFRICA	14	14B	7	7	7B	7B	7B	14	21A	21A	21	14
U. S. S. R.	7B	7	7	7	7	7B	7B	7B	14	7B	7B	7B
EAST COAST	21	14	7	7	7	7	7	14	21A	21A	28	21A

A - Next higher frequency may also be useful.
B - Difficult circuit.

Good: 3-6, 11-14, 18-21, 23-25.
Fair: 1, 2, 7, 8, 15-17, 22, 28.
Poor: 9, 10, 26, 27.

($1,000,000 TVI Suit from page 37)

their findings would be reported to the Miami office of the FCC which has jurisdiction in this case.

On October 25, I spoke with Mr. Gilbert, the Engineer in Charge of the Miami FCC office, to see if a determination had been made in the case. He said that the FCC could find no cause to limit Mr. Gridley's operation and that Mr. Eggers' attorney had been notified to that effect. He said that he considered the case closed inasmuch as the FCC no longer had jurisdiction over what is in essence a dispute between two neighbors.

On October 26, the original pre-amplifier was re-installed at the TV antenna upon the insistance of Mr. Eggers. The Jerrold amplifier and the high-pass filter were removed. This TV set is, therefore, in its original configuration, which exhibited the maximum amount of interference.

On October 31, a suit was filed in the Circuit Court of Sarasota County against Mr. Gridley. Among other things, the suit states:

> "That said radio station was erected and is maintained in a negligent and unskillful manner, and by reason of this negligence and want of care in the construction, operation and maintenance of said radio station since the year of 1958, Defendant still does maintain a nuisance, causing much discomfort and vexation to your Plaintiff by not allowing him to enjoy his radio and television sets because of this constant and considerable interference, and this aforesaid nuisance constitutes an electronic invasion of privacy in the home of the Plaintiff."

The suit asks that Mr. Gridley be restrained by injunction from maintaining or using his amateur station and that Mr. Eggers recover $1,000,000 damages.

Mr. Richard V. Harrison, attorney for Mr. Gridley, has contacted the ARRL General Counsel in Washington and has requested support in this matter. Mr. Harrison has also moved that the case be heard in the Federal Court in Tampa, and that Mr. Eggers be enjoined from publishing in the newspapers any material referring to Mr. Gridley or to "ham operators." A total of five advertisements containing "editorials" have appeared in the newspaper since the start of the case.

It is understood that a hearing on this case will be held in the Federal Court in Tampa on January 8, 1969.

The TVI Committee believes it has exhausted all possible methods to effect a solution to this interference problem. However, a final solution cannot be effected until the complainant agrees to cooperate by allowing the necessary corrective action to be performed. Nevertheless, the committee will continue to monitor the events as they occur and stands ready to assist if requested.

A note from Grid points out that there never has been a precedent set in a suit of this type in ham radio and that an adverse ruling, no matter how unlikely, could mean the end of amateur radio as we know it today. Grid needs help, legally and financially, to see him through this nightmare.

A.E. Gridley W4GJO
1966 Hillview Street
Sarasota, Florida 33579 ■

Roy Ferren W6EKN
131 S. Anita Ave.
Los Angeles, Calif. 90049

CW Only Here, OM

As a true believer of the delicate art of CW, I used to wonder since World War II, if I was still living in the age of high button shoes and buggy whips, but I no longer do, and here is why:

I made my conversion at a tender age from the life of a normal, red blooded American boy to a strange character who spent long night hours listening to weird noises from the 201A's in a super-regen receiver. The sheer joy of first copying completely a message from start to end has seldom (I siad "seldom") been equaled to this day. I was a superior being—I was in an esoteric society of superhumans who had their own language, and greatest of all—I was privy to secret conversations coming through the night in fair weather and foul.

Since 1928 (my "ticket" year) I have steadfastly held my head high and refused to be seduced by the "phone" boys—or as we now say the "SSB" types. "Lips that touch liquor shall never touch mine" were mild compared to my firmness that, "A hand that caresses the bug shall never hold a mike." My rationalization for this attitude was a thing of beauty and joy forever. I said, in my pristine purity, "I talk all day on the telephone, so why should I spend my precious time shouting into a mike!" For this I have suffered the opprobrium, slurs, and downright insults of my fellow hams, but I have resolutely turned my cheek.

Now after 38 years of "CW only" (I started young—so none of that "Old Timer" stuff) I feel my lonely stand against the ubiquitous "phone man" is slowly being vindicated. I am sort of a strange breed that can best be described as a "DX ragchewer" or a "Ragchewing DX'er." I do this by sitting quietly in front of my 75A4 watching the heat waves rise from the Henry 2K final and slyly swinging around the wide spaced single band Yagi to those directions wherefrom the sweet and pure sigs come for me to snare. When this occurs I then subtly start questioning the victim in English, French, or Spanish to encourage him to break the deadly pattern of the "RST, QTH, QSL, 73" hackneyed QSO's heard constantly on 14 MHz. Sometimes I succeed, sometimes I don't, but when I do I get some interesting answers. Among these answers comes forth the fact that a number of dedicated phone men are reluctantly deserting the ranks of SSB for the honorable art of CW. Why? Mainly, because they are bone tired of the incessant flow of chatter, endless repetition, and the use of "cute" phrases. They want to again enjoy the crisp, clear interchange of ideas, thoughts, and information through the use of CW which by its nature forces clear thinking into few words. Objectively, I think this is good for amateur radio. It gives a healthy transfusion between disciplines and keeps alive that spark of uniqueness in amateur radio of "Let's do it differently, and better."

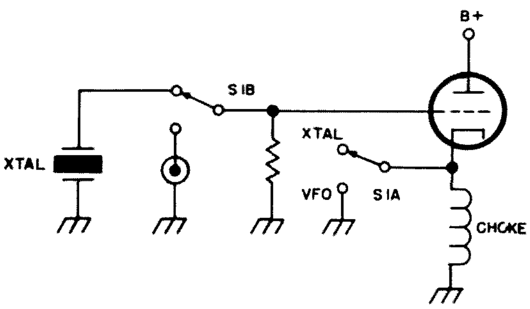
. . . W6EKN

HI-HO-HUM

Are you getting signal reports that you have a sixty cycle hum and your modulation is distorted, when you use your vfo? Is it possibly a leaky pair of electrolytic condensers in the power supply of your transmitter? Or, could it be a broken shield on your mike cord? Nine times out of ten the vfo is causing the hum.

How come it is the vfo? In commercial radio amateur or "home brew" trsnsmitters, the cathode of the oscillator tube sometimes has a choke or a choke and resistor to ground. Now this is fine if you use a crystal but if you use a vfo with the choke or choke and resistor still in the cathode circuit, you are above ground and there is the hum.

To cure this problem, the cathode must go straight to ground eliminating the choke when you use the vfo. A DPDT switch (see **Fig. 1**) will make it easy for you to use a xtal or a vfo without any hum.

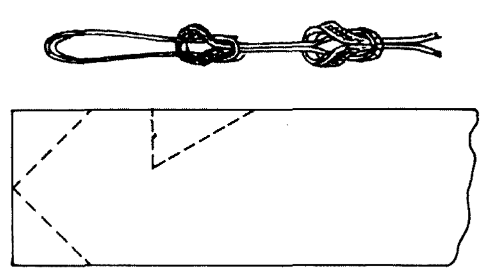


. . . K6GKX

Superslingshot for Stringing Antennas

Hams have often used trees to support antennas. Unfortunately, the trees could not always support the ham as well. The casualty rate is somewhat lower for those who put the antenna in the tree by the bow and arrow method, but a suitable bow may run ten or twenty dollars and there's all those arrows too. You can always try throwing something, but if you're fat and forty or just plain out of shape, you may find that heaving a chunk of stone almost straight up feels harder than it looks.

My solution is better than a wrenched elbow and cheaper than a good bow. Buy a package of rubber bands, size 16 should do, and link fifty of them in a row as shown in the figure. You must loop the end ones as shown or the string will come apart.



Take 18 inches of 1x2 wood or broomstick and cut the head as shown. Lay out a light nylon string 2½ times the height you want in large loops and attach the top end to the tail of the "arrow". Now, using a tall ladder and the rubber band string as a giant slingshot, notch the arrow, pull back as far as the bands will allow (3-5 feet), aim and let fly. If more power is needed to put the arrow over the limb of the tree, heavier bands will give your arrow more fling. So what if the neighbors think you're crazy, they know you're a ham.

. . . WA4VQR

Warning!! If the bands should break, the backlash could be severe. Draw to the chest, not to the eye! Ed.

104 Easy Transistor Circuits You Can Build, by Robert M. Brown

A hundred and four useful circuits, ranging from really simple or novel devices such as a light-activated oscillator to receivers, transmitters, and test instruments. There is something for any interest, or any wallet, in this book, and many of the circuits are of the extremely uncritical variety that can be assembled easily from junk-box parts if other materials are not available.

For instance, a power supply circuit described in the introduction, uses a simple current-regulating circuit in place of a zener which may be hard to get, and works very well with almost any available transistors of the correct polarity. The introduction also contains several paragraphs on substitution of available transistors for those listed in various projects.

Specially noted in the book were projects for several code practice oscillators, some CB gear, VHF as well as HF circuits, several test generators, and an efficient battery charger that will automatically switch over from charge current to a small trickle current as soon as the battery reaches full charge.

"104 Easy Transistor Circuits You Can Build" is available from your distributor or from Tab Books, Blue Ridge Summit, Pa., 17214, for $6.95 in hardcover (recommended) or $3.95 in paper.

99 Ways to Use Your Oscilloscope

If you have a 'xx 'scope, this book will be invaluable to you. If you don't have a 'scope then get one. Also get the book. It shows you how to test just about any circuit you are liable to run into, complete with the waveforms that you should find. Servicing color? Here is the info. What to do with an IC circuit? Transistors? All right here, with waveforms. Curve tracing for transistors? Diodes? Zeners? Here too. TAB Books, Blue Ridge Summit, PA 17214. Probably available from your local distributor for $6.95 hardbound (best) or $4.95 in paper. This book will give new life to your 'scope.

Caveat Emptor?

★ **Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

★ **Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.**

★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

★ **We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.**

★ **For $1 extra we can maintain a reply box for you.**

★ **We cannot check into each advertiser, so Caveat Emptor . . .**

ANNUAL W2-DX ROUND-UP Saturday, March 22, 1969 (Saturday prior to IEEE Convention) at Holiday Inn of Newark, 430 North Broad Street, Newark, New Jersey. Starts 1 P.M. Ticket basis—afternoon program only, or total package with prime rib banquet. Afternoon program will include talks on speech processing, antenna performance, DX panel on "How To". Door prizes. Conveniently reached by train, subway, auto, and bus. Further details call W2LA. Also call 201-226-4545 or 212-344-2997 both daytime.

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500 GREAT CIRCLE bearings, return bearings, distances, time differences, zones, computerized to your QTH. $3.00. Samples, 25¢. Bearings, 122 Lockhart, Princeton University, Princeton, N.J. 08540.

HALLICRAFTERS HT-37. $210, good condition, clean, no rust spots, and low mileage. Bob Koepke, W9IHI, 344 Oriole Lane, Madison, Wisc. 53704.

ALL HAMS, particularly college students, interested in pure physics and physics-philosophy, are invited to join Die Physik Gruppe, a group which will get on the air regularly and ragchew physics, especially pure physics and physics-philosophy. Please write Aron Faegre, WA9FJG/7, Box 318, Reed College, Portland, Oregon 97202. Discussions will not be in German!

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3 PLASTIC HOLDERS will frame and protect 60 cards, $1.00—or ten holders $3.00. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, Tenn. 37066.

RECEIVER BAND changing switch 25¢ postpaid. Send for our surplus electronics parts and equipment flyers. Bob-Frank Electronics, PO Box 1327, Harrisburg, Pa. 17105.

ORIGINAL CONDITION, 1923 RCA radio. Has oscillator, wave length, loop regeneration knobs, tubes and transformers. Excellent condition for age. Best offer over $100. W. C. Smith, 8679 45th St., Glen Avon, California 92509.

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19 ASR TELETYPE for sale. A-1 mint condition, factory reconditioned. $150. C. Vinson W2GJJ, Larkspur St., Yorktown Heights, New York 10598.

REGULATED POWER SUPPLIES, without transformers, .6-4 AMP, $2.75 to $8.50. Zeners, thermistors, $.25. 10A Triac, $1.75. Diodes, $.05. Nixies with driver, Burroughs #B6091, $9.50. Catalog. Murph, 204 Roslyn Ave., Carle Place, New York 11514.

LONG RANGE TV reception easy! Booklet outlines methods to receive distant TV stations using inexpensive materials. $1.50 postpaid. PRACTICAL PLANS, Box 56-K, Killeen, Texas 76541.

WANTED: ½" paper tape for Boehme CW keyer. Send your price and amount available to Robert R. Smith WB6ODR, 13209 Idyl Drive, Lakeside, California 92040.

COLLINS: 51J4 w/3kc filter, excellent condition, $700; KW-1 transmitter, excellent condition but needs bias transformer available from Collins for $53, $700. Shipping paid. Paul Reid, 405 4th Place, Merritt Island, Florida 32952.

VHF GEAR. Three Clegg 22'ers, $160 for one, 10% off for two or all three. 6 Meter Gonset Communicator III, $130. No personal checks. Barrie C. Hiern, K5SGP; 1506 Cross Lake Blvd., Shreveport, Louisiana 71109.

FOR SALE: 6 meter Hallicrafters AM SR-46 transceiver w/HA-26 VFO and Mobile kit. Mint Condition, $100. Joel Eschmann K9MLD, 2036 Erie Street, Racine Wisconsin 53402.

WRL'S USED GEAR has trial—guarantee—terms! HW22—$89.95; Swan 350—$279.95; Galaxy 300—$139.95; V—$249.95; Vmk2—$299.95; HX500—$269.95; HT37—$199.95; NCL2000—$449.95; SB300—$229.95; NC155—$119.95; RME6900—$149.50; Collins #312B5—$199.95; hundreds more. Free "blue-book" list. WRL, Box 919, Council Bluffs, Iowa 51501.

RUSSIAN AMATEUR TRANSMITTER type CCCP-SVIAZ for sale, best offer accepted. George WA4NQR, 102 Willow Rd., Savannah, Georgia 31407.

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25 YEAR COLLECTION electronic sound equipment, tape recorders, speakers, microphones, parts, technical magazines, collectors' items. Los Angeles 383-8718 after 8 P.M.

RUSSIAN TYPE CCP VSIEM amateur transmitter for sale. Best offer. W4MQU, Jacksonville, Fla., 1563 San Marco Blvd.

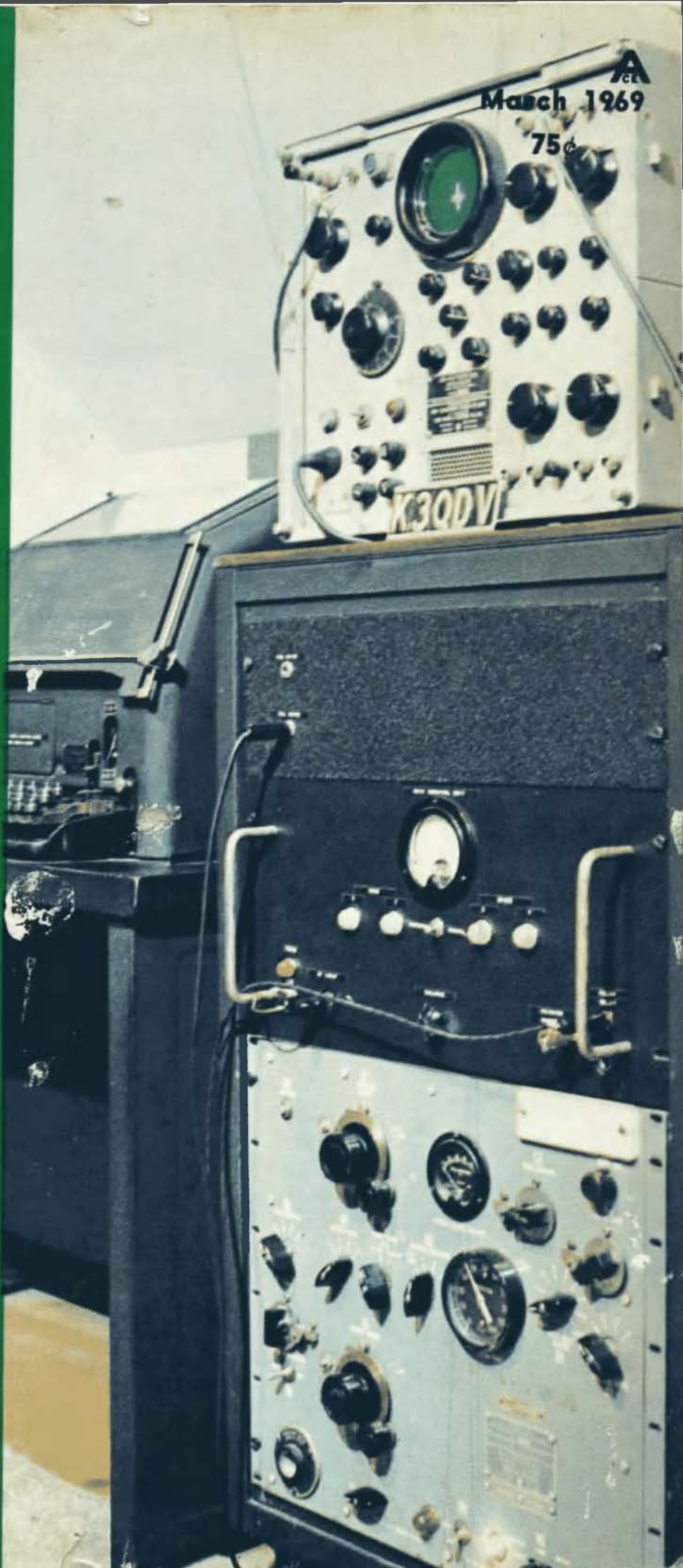
RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $2.00 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

DAYTON HAMVENTION April 26, 1969: Sponsored by Dayton Amateur Radio Association for the 18th year. Technical sessions, exhibits and hidden transmitter hunt. An interesting ladies' program for XYL. For information watch ads or write Dayton Hamvention, Dept. S, Box 44, Dayton, Ohio 45401.

AMATEUR RADIO 73

March 1969

75¢



SPECIAL SURPLUS ISSUE

Giant Catalog of surplus dealers begins on page 97

Surplus Conversion Articles

Electronic Keyer

Extra Class License Part II

73 MAGAZINE

March 1969
Vol. LXIX No. 3

STAFF

Kayla Bloom W1EMV
Editor

Wayne Green W2NSD/1
Publisher

William Beatty
Advertising Manager

Cover Photo: A Surplus ham shack in operation. Photo by Clarence Snyder W3PYF. Equipment consists of Model 19 Teletype, AN/USN24A Scope, FSA/FSK, and related home-brew equipment constructed from surplus parts.

Contents

Departments

73 Magazine is published by 73, Inc., Peterborough, N.H. 03458. Subscription rate: $12.00 for Three years, $6.00 for one year. Second Class Postage paid at Peterborough, New Hampshire, and at additional mailing offices. Printed at Pontiac, Illinois, U.S. Entire contents copyright 1969 by 73, Inc. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.

Editorial Liberties

OK, I finally allowed the camera to take a picture of the Editor. So . . . stop nagging, already. On the left is the camera eye's view of your editor. A benign, friendly, motherly gal. On the right is a cartoon I found taped to the file cabinet next to the drafting table here at 73. This shows what at least one of my fellow workers sees in me! Perhaps I should mend my ways?

For years, our annual surplus issue came out in June. At the request of many of the surplus dealers, we advanced it to March. The complaint is that June is not a "project" time. Perhaps October would be even more appropriate, since with the advent of the long winter months, those living in the north abandon boats and other outdoor activities, and begin planning for inside building projects.

In any case, there is a dearth of surplus articles coming across my desk. Following World War II, the conversion of surplus constituted much of our amateur equipment. These days, there doesn't seem to be much new material. Most of it finds its way into the MARS programs, and much apparently is simply destroyed, since it is highly classified. I wonder if amateur radio may not be nearing the end of another era?

It is becoming increasingly evident that the number of new hams is decreasing each year. It is also evident that the number of hams who are going for the higher class licenses, is not up to the expectations of either ARRL or FCC. This brings us to speculate on various reasons for both situations.

There was a time when one could walk into an FCC Field Office and request to take the exams. There was a later time, when mornings were available each day during the week for those wishing to take the exam. Now, you look at the list of FCC offices and times of examination, and the restrictions are pretty grim. In many cases, you have the choice of getting to the office at 0800 the third Friday of the month, or not taking the test.

This is a hardship. For the person who lives in a large town which has a Field Office, perhaps it is not too bad. I live 80 miles from the nearest FCC office. This is 80 miles, for the most part, of winding country roads where the speed limit is about 40. This means a two hour drive on a work day morning, arriving in a state of physical and psychological exhaustion from fighting the morning traffic, and facing the noise and confusion of perhaps 50 other examinees in one room.

I haven't copied code with a pencil for many years. I use a typewriter. In a crowded room, a typewriter makes more noise and confusion, so FCC says I can't use one. I've been using a typewriter for so long that I can hardly write anymore. At least not so anyone can decipher my scrawl. So, I have to go back to learning how to use a pencil before I can qualify for the Extra.

I do not advocate easier exams. I do think it would be a not too difficult task for the local Field Offices to make examining conditions more relaxed and less restricted.

I suspect if the FCC offices were not so full, there would be fewer failures.

. . . Kayla—W1EMV

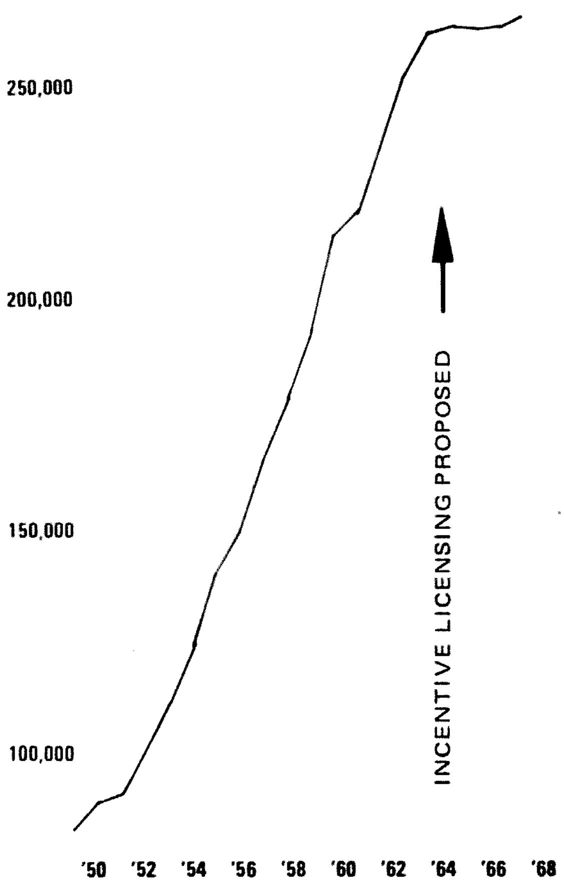
...de W2NSD/1

Wayne Green

The chart below is based upon the FCC figures for the number of amateurs licensed each year for the last twenty years. As you can plainly see, the amateur ranks were swelling at the rate of about 13,000 per year fairly regularly until 1964, when the growth virtually stopped.

While the sudden stunting of amateur growth is strangely coincident with the announcement by the ARRL of their Incentive Licensing proposals to the FCC, I realize that I have been perhaps a bit tedious in my finger pointing at this particular outrage (in my view) and that there may be other factors which brought about the results which I predicted.

Be that as it may, there are several reasons why it is important for us to get that growth curve back on the track. Though portions of our lower bands are reasonably active, there are wide areas of our higher bands that desperately need more activity.



We have acres and acres of room for growth in VHF bands. And if we don't start growing into these frequencies there is not the slightest question that we will start losing them. I don't know if it is necessary to open up the top end of ten meters to the Novices, but I do know that we darned well better do something to get some activity up there or else it could turn into another Citizens' Band, or even worse. Well, it probably couldn't be worse. Ten was a lot more active ten years ago at the time France made a major try to get the ITU to authorize them to use the top megacycle of ten meters for local low powered communications with the proviso that amateur radio could continue to share the band as long as it did not interfere with their communications. Fortunately this rule change was voted down at the time.

Pardon my digression, but I wanted to show that every one of our frequencies is badly wanted by other services and you can bet that they are ready to pounce on anything we leave unused for any length of time.

The use of our frequencies is only one part of the protection we can give them. Frequency allocations are a political matter, unfortunately, and it is important that we recognize this and act accordingly. We all realize that amateur radio is of tremendous importance to our country. We know that the electronic industry and the communications industry in our country could not possibly have grown at the rate it has without the hundred thousand or so amateurs who are working in them. We know that our preparation for the last war would have been much much longer if we had not had tens of thousands of amateurs available as radiomen, electronic technicians, and teachers. Communications and radar were of critical importance in our winning the war and these might have taken years longer to press into effective use had it not been for our amateurs.

We need only look around at other countries to see the importance of radio amateurs. Where

(This goes on and on on page 77)

Modernizing the TCS Transmitter

Robin Gaardsmoe K3UUL
11831 *Charles Rd.*
Silver Spring, Md. 20906

The TCS transmitter is as fine a piece of workmanship as can be found. However, it suffers from a common problem with surplus gear—it was designed to perform as part of a group of equipment and in a manner useful to the military. Herein are some simple changes which will fit this fine instrument into typical amateur patterns of operation. The word simple must be stressed. There is no point in spending days stripping the entire circuitry and building a whole new transmitter in the frame. These modifications will require about four to six hours and very little in the way of parts or machining.

There are four logical steps to the conversion of the TCS. First, if you do not have the companion power supply, one must be built. Obviously, this will require much more than the aforementioned four hours. But it is likely that a better supply can be built, by the ham with a typical stock of "junk" parts, for less than the original version can be purchased. (i.e. under $40.00).

Second, conversion to cathode keying will be covered. As designed, the TCS is keyed by applying and removing B+ on the final tubes, at a keying rate, with relays. In the AM mode, this is a satisfactory method. When using CW, however, this type of keying is completely unacceptable.

The third phase involves modification of the output circuitry to provide optimum transfer of power to a matched 50 ohm line. This is the antenna system used by the author, and therefore, the only one for which specifics can be supplied. The basic concept of the output tank will be discussed in hopes of enabling those using tuned lines, non-resonant antennas, etc., to experiment and find a solution suitable to their particular installation.

As a final phase, we will take a brief look at boosting the audio of the modulation stage, a necessary step if AM use is contemplated.

Power Supply

If you desire to build a supply for your TCS, the first step is to change the power plug, P_{101}, to a common type. Fortunately, the hole occupied by the existing P_{101} is exactly the right size for an octal socket. So, remove the leads from P_{101} and label each by pin number as you move them aside. Secure a male octal plug, the type with a locking ring, and install it in the hole formerly occupied by the multi-pin P_{101}. Re-connect the leads according to **Table I.** In addition, connect a 0.01 mfd disc capacitor to ground from each of the new pins except number 5.

Old pin #	New pin #	New Function
2	1	Final tubes B+
7	2	ac on loop
12	3	ac on loop
13	4	12.6 vac—filaments
15	5	Ground
14	6	Oscillator & Buffer B+
16	7	12.6 vdc—relays
—	8	Relay switching—see "keying mod."

TABLE I.

The remaining leads which are not shown connected in **Table I** should be removed or tied back and insulated. They are not required when the transmitter is used without the companion receiver.

The power supply is straightforward and requires little discussion to supplement the schematic, **Fig. 1.** As designed, the TCS power supply provides 400v B+ on the final tubes. However, this voltage level will not realize full power output, approximately 65 watts, with some output configurations. The 1625 tubes used can easily operate with

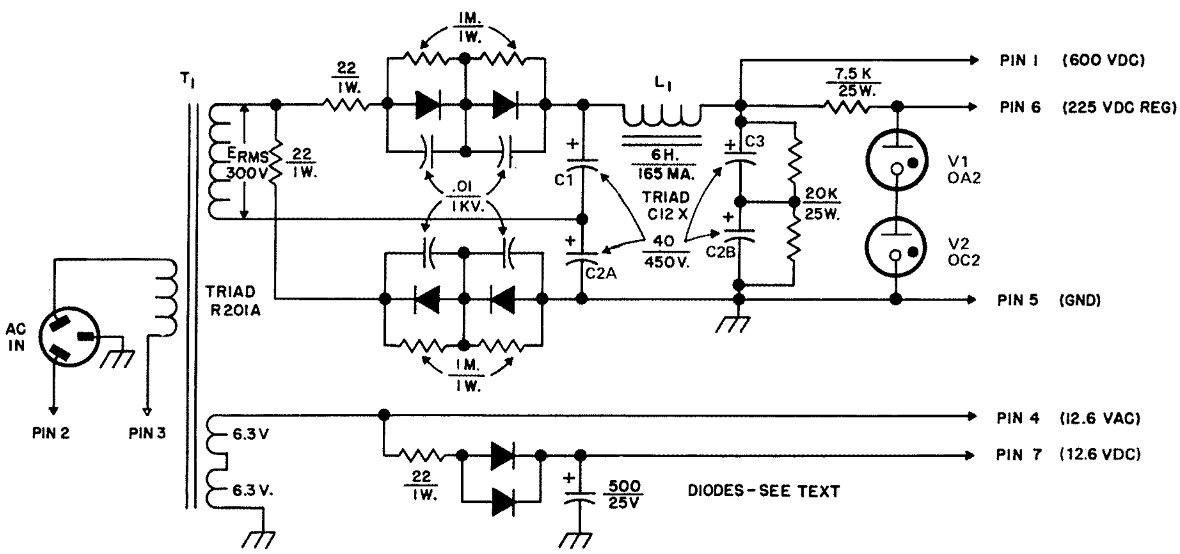


Fig. 1. Schematic diagram for the TCS power supply.

600 V on the plates. Therefore, selection of a high voltage secondary for the power transformer may range between the 400 V to 600 V level with output power varying accordingly. The transformer shown in **Fig. 1** uses a voltage doubling rectifier, yielding about 600 Vdc at pin 1. It is an excellent combination of high voltage and filament windings at a reasonable price, but is by no means the only one available.

Medium voltage is regulated at 225 V by V_1 and V_2 in series. The load on the regulated line is constant, therefore VR tubes can be used despite the fact that the load may exceed the rating of the tubes. Note that C_1 and C_3 must be separate units. A common negative, dual type will not do. C_2 may be a common, can-negative type, however.

Since everyone has a different source of the hundreds of types of silicon diodes on the market, a stock number is not called out. When selecting diodes, use the rule-of-thumb:

$$PIV_{total} = 3 \times Vac_{rms}.$$

Thus, using the transformer shown, $PIV_{total} = 3 \times 300 = 900$ V. If your diodes are rated at 400 V PIV, for example, you *must* use three of them in series in each leg. Failure to observe this rule will invariably cost you a diode or two. Place a .5 to 1 megohm, 1 watt resistor and a 0.01 mfd, 1 kV disc capacitor in parallel with each diode whenever two or more are used in series, in order to equalize current distribution and damp voltage spikes. The 22 ohm, 1 watt current limiting resistors in each leg are essential in a capacitor-input power supply.

12.6 Vac is required for the filaments. This particular transformer has two 6.3 Vac windings of equal current rating. If you connect two such windings in series out of phase, there will be no output. Should this occur, simply reverse one winding connection.

The entire supply can be housed in a 4 x 5 x 6 inch minibox and mounted on the rear of the transmitter case.

Keying modifications

Following is a step-by-step procedure for converting to cathode keying. It is an extremely simple operation, literally requir-

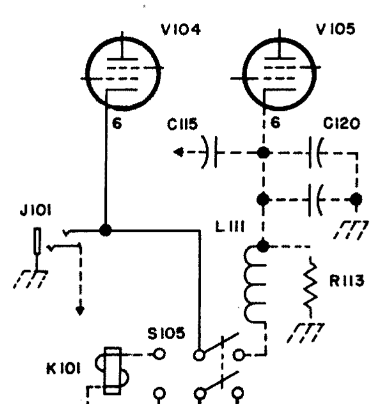


Fig. 2. Converting the TCS to cathode keying. Solid lines show conversion.

ing only fifteen minutes, but well worth while. (See **Fig. 2.**)

1. Remove the transmitter from the case and lay it upside down. locate X_{104}, the socket of V_{104}. Next, locate pin 6. Pins 1 and 7 are the large tube pins—the filaments. Looking down on the bottom of the socket from the front, the left-hand large pin is number 7. Count counterclockwise to pin 6 and unsolder all leads from it. These leads are all heavy bus-wire. Push them clear of the socket and solder them together again. A tie-point is not necessary.

2. Locate the "tip" contact on the three-way "Key" jack, J_{101}, and unsolder the two leads from it. Move them temporarily aside. Now solder a five inch length of hook-up lead to this contact. Route the other end to the "Voice/CW" switch, S_{105}.

3. On S_{105}, unsolder the solid white wire on the center contact of the side *away* from J_{101}. Remove or tie back and insulate this lead. It will not be used.

4. Connect a lead between pin 6 of V_{104} and the contact just vacated on S_{105}. Also solder, at the same contact of S_{105}, the five inch lead from J_{101}.

The cathodes of V_{104} and V_{105} are now lifted from ground and will be keyed during CW operation. On AM V_{104} is turned off and V_{105} will be keyed by a normal PTT operation. All that remains is to provide for the switching of K_{102} and K_{103} when going from receive to transmit and vice-versa.

5. Remove the large ground screw from the front panel. About one inch directly beside this drill a clearance hole for a #10 screw. From the front insert a ½ inch long #10 screw and re-connect the ground leads from the old ground lug. Secure them with a nut.

6. Enlarge the old ground-screw hole to accept a SPST toggle switch. Mount the switch and connect one contact to the new ground lug beside it. To the other switch contact, connect the two leads previously removed from the "tip" contact of J_{101} (Step 2). To this same switch contact, connect a lead to pin 8 of the "Power" plug, P_{101}.

Steps 5 and 6 have added a "Send/Receive" switch to the front panel of your TCS. In addition, pin 8 of the power plug is paralled with it and may be used (in

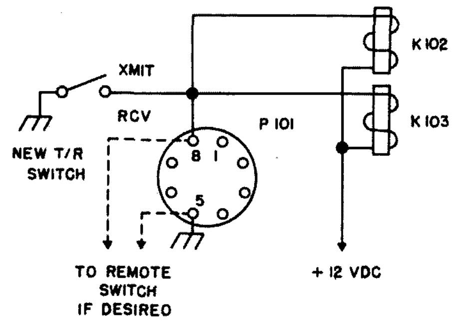


Fig. 3. Steps 5 and 6 of keying modification.

conjunction with pin 5) as a remote switch or relay control of the same function.

Output modification

The antenna circuitry of the TCS is designed to load an unmatched 20 foot whip with single-wire feed. Series inductances are provided, internally and externally, to permit reasonable matching over the frequency range. At best, this is an expedient system and can be vastly improved upon.

At this station, a 23 foot, base-loaded vertical is used with 50 ohm coax feedline. From a space economy standpoint, this is perhaps the most desirable antenna system for the low frequencies of the TCS. Certainly, a more efficient system would be an end-fed long wire. but this requires infinately more room.

7. To begin with the modification, disconnect and remove E_{105} and E_{107}, the "Receiver" and the "Antenna" terminals. Enlarge the two holes to accept coax connectors—type UG-657 (BNC) connectors fit the holes without the need for enlarging. Re-connect the two leads to the new coax connectors.

8. Next, disconnect and remove the roller-coil, L_{108}, marked "Antenna Loading". Temporarily leave the two bus leads (from L_{107} and S_{103}) hanging. The coil is held in place by the four corner screws of the panel-plate, and two screws, in the rear of the roller-coil, attached to a bracket. By removing V_{104} and V_{105}, the latter mounting screws are accessable.

9. Remove capacitor C_{121} and the ceramic stand-off on which it is mounted. In place of this, mount a similar type capacitor with a value of 1000 mmf (i.e. Centralab 858S-1000). This capacitor mounts with one end grounded directly on the transmitter frame. Refer to **Fig. 4** for later connection of the other end of the new C_{121}.

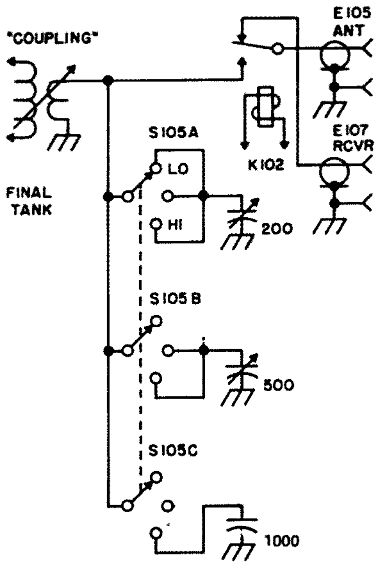


Fig. 4. TCS output modification.

10. Next, using 1/16 or 1/8 inch aluminum plate, fashion a cover plate for the hole from which L_{108} was removed. The face-plate of the roller-coil may be used as a template for the perimeter shape and position of the four corner mounting-screw holes.

11. Secure one of the myriad types of ac-dc receiver tuning capacitors having two gangs. Almost any will do, so long as one section will tune to about 500 mmf and the other around 200 mmf. These values are certainly not critical. Mount this capacitor on the cover plate you have just made, making sure the rotors ground to the transmitter frame. Before mounting, connect about six inches of buss wire to the stators of each section, positioned towards S_{103}, the "Antenna Condenser" switch.

12. Carefully bend the buss lead from L_{107}, left by the removal of the roller-coil toward the relay K_{102}. Solder it to the same relay contact as the lead going to C_{121}.

13. Now, remove all wiring from the "Antenna Condenser" switch, S_{105}. It will be necessary to carefully straighten the buss wire lead from K_{102}, referred to above, in order for it to be long enough to reach the proper contact when rewiring S_{105}.

14. Refer, now, to **Fig. 4** and make all connections at S_{105}.

When completed, this switch becomes a Low-Medium-High capacitance range switch, all in parallel with the antenna link of L_{107}. By proper selection of range, and experimental balancing using the "coupling" control and the new "antenna loading" capacitor, you can obtain optimum power transfer to a matched 50 ohm antenna throughout the frequency range of the TCS.

Essentially, the requirement which must be satisfied is to make the link-output appear as 50 ohms reactance to the load at the frequency in use. The rotatable link does not satisfy this condition as designed, so it is necessary to include a circuit variable which will. Obviously, another approach to the problem would be to remove the link coil, calculate the proper inductance to provide 50 ohms reactance and re-wire the link. However, the removal of this coil seemed to be considerably more of a mechanical problem than the construction of the circuit of **Fig. 4**. In addition, this method offers much more flexibility.

Audio modifications

Most amateurs prefer to use ceramic or crystal type microphones rather than suffer with the poor quality and mechanical problems associated with carbon mikes. Thus it behooves one to add pre-amplification to the audio stage in order to realize sufficient modulation percentage as compared to carrier power.

In summary, after these modifications are complete, you have an efficient, compact, low-power transmitter capable of continuous tuning from 1.5 to 12 MHz. Aside from covering the obvious amateur bands, most of the major MARS frequencies are available, particularly those of Navy MARS which are impossible with most ordinary ham equipment. Ideas will occur to many of you, which I have overlooked, because each of us have different uses for the little rig and diverse systems into which it must blend. This is what makes surplus modification so interesting. . . . K3UUL

A $4 Compressor/Preamplifier

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By the addition of a few extra components to an inexpensive, already assembled transistor audio amplifier, one can produce a very satisfactory but yet inexpensive audio compressor for use between almost any microphone and AM or SSB transmitter.

The author has constructed many different types of audio compressors and has become convinced that under poor signal conditions and with transmitters lacking effective alc, that they are a definite advantage. The problem in constructing a compressor is that either one must start from scratch, assembling all the necessary components, or search out some piece of equipment to modify. The latter course has been used by the author using a high quality phono preamplifier. However, it certainly was not the cheapest way to proceed although the results were very good.

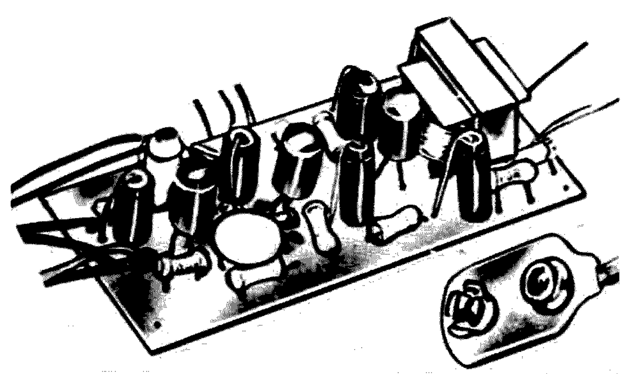
Therefore, the idea came to mind to try to modify one of the small, preassembled 100 to 200 mw audio amplifiers which are readily available at prices from $2 to $4. These imported audio amplifiers were built for use in inexpensive battery-type tape recorders and typically contain 3 or 4 transistor stages with a medium to high impedance input and a transformer coupled output to match a 4-8 ohm speaker. The results that were obtained after such a unit has been modified were indeed surprising. Distortion was quite low—at least in the 300 to 3,000 cycle range—and the compression range of about 14 to 20 db equalled that of many more expensive designs.

Only a handful of components is necessary to effect the change of the amplifier into an effective compressor and they can be readily purchased or are probably even available in most "junk box" collections. The conversion described for the amplifier used by the author is typical and can be applied to any generally similar unit.

Circuit modification

Fig. 1 shows the original diagram of the audio amplifier used, a Lafayette model 99-9039 100 mw output model. To provide compressor action some method had to be used which would allow control of the gain of the amplifier so that it would decrease automatically as the input signal level increased. There are many ways to perform this function.

Fig. 2(A) shows a very simple and effective means employing an absolute minimum of added components. In this circuit, part of the output of the 2SB176 stage is rectified by the IN270 diode. This voltage is used to bias the other IN270 diode which is connected in the microphone lead after the 47 K ohm resistor. Increased amplifier output causes the IN270 in the input circuit to be biased so it presents a low resistance to ground. In conjunction with the 47 K ohm resistor it then forms a voltage divider



Typical small 3 stage audio amplifier. Additional components for compressor control circuit are easily mounted on underside of printed circuit board. Entire assembly may be placed inside transmitter or a small minibox.

network which reduces the input signal feed to the base of the first 2SB113 stage. The value of the 47 K ohm resistor can be varied to provide the desired compressor action and also to work best with a particular microphone. The only disadvantage to this scheme is that compression action starts almost immediately on the input signal rather than at some preset "threshold" level.

This disadvantage can be overcome by the only slightly more complicated circuit of **Fig. 2(B)**. In addition, this modification introduces some degeneration which helps to improve the frequency response and lower the distortion of the amplifier. The operation is somewhat similar to the previous circuit in that two IN270 diodes are used to rectify part of the output from the collector circuit of the 2SB176 and used to control the resistance of another IN270 diode. The latter diode is connected in series with the emitter bypass capacitor of the input 2SB113 stage. In addition, there is a "threshold" biasing circuit consisting of the 100 K ohm and 25 K ohm resistors connected to the diode. Increasing output from the 2SB176 stage causes a rectified voltage to be developed which acts to back-bias the diode in the 2SB113 stage emitter circuit and thus nullify the action of the emitter bypass capacitor and reduce the stage gain. This action cannot, however, take place before the rectified control voltage exceeds the "threshold" control voltage developed across the control diode by the 100 K ohm and 25 K ohm resistors. Thus, compression action is "delayed" for very low level input signals and the amplifier essentially operates at full gain for these signals.

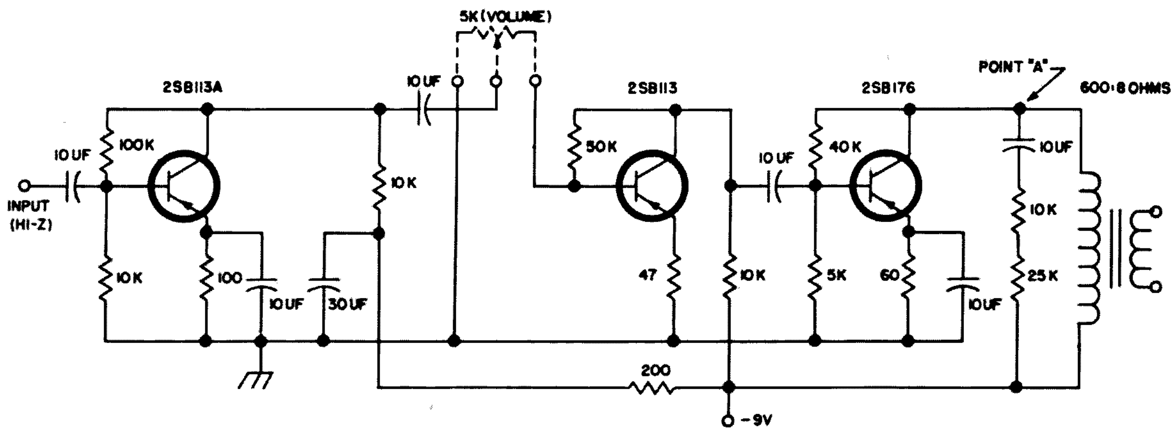


Fig. 1. Schematic of Lafayette 99-9039 *amplifier before conversion. Unit is similar to many inexpensive* 100 *to* 300 *MW class amplifiers available on market.*

A further refinement which is not absolutely necessary but which does provide an additional degree of convenience is to replace the gain control shown in **Fig. 1** with a fixed value resistor and place a 1 to 5 K ohm potentiometer in the emitter circuit of the input 2SB113 stage (in series with the 100 ohm resistor). The potentiometer will then function as a compression control with the amplifier acting as a straight preamplifier without compression action for large

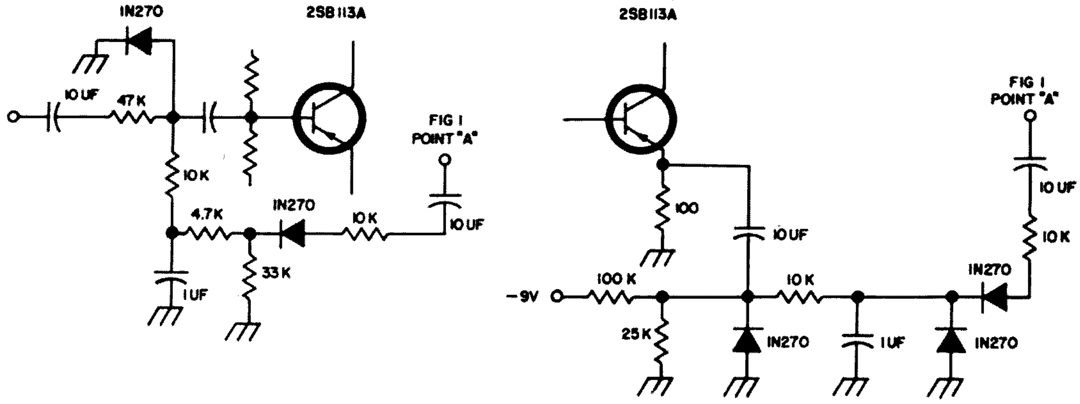


Fig. 2. Simple compressor control circuit (A) and slightly more elaborate circuit (B) providing "threshold" action.

resistance settings of the potentiometer and increasingly as a compression amplifier as the potentiometer resistance is decreased.

In the unit used by the author, output coupling for the IN270 rectifiers could simply be taken from the single-ended 2SB176 stage using the components already available as a frequency compensating network across the output transformer. Using units with push-pull output stages, a similar coupling network consisting of a 10 mF capacitor and 10 K ohm resistor in series coupled to *either* collector lead of the output stage should suffice. The output side of the output transformer is designed to operate into a low impedance load. To operate it into a high impedance microphone input on a transmitter, it will usually suffice to just place a 47 K ohm resistor in series with the output winding. The power available at the output is considerably reduced by this method but this is normally of no consequence for the usual high-gain transmitter microphone input. Otherwise, a matching transformer can, of course, be used to effect a more conventional impedance stepup.

Construction

The addition of the few additional parts necessary to turn the amplifier into a compressor can easily be accomodated on the printed circuit board of the amplifier. No particular placement of the components is necessary and if one takes a careful look at the layout of the printed circuit board, it will usually be found that almost all of the additional components can be placed on the underside of the PC board. Where tie points are necessary, a small hole can be drilled in a clear area on the PC board.

Most of the amplifier circuits are designed to be operated from 9 volt transistor batteries. A rectifier circuit can, of course, be constructed to power the unit as a compressor but usually it will be found to be far simpler to operate them from a battery supply. Since no power output is demanded from the amplifier circuit, the battery drain will only be a few milliamperes under normal operating conditions. Otherwise, if a power supply is used particular attention must be given to adequate hum filtering. The power supply should have an output capacity of 1000 mF as a minimum.

Operation

There are many ways to evaluate the performance of a compressor unit. On the air tests are only useful if they are conducted under weak-signal conditions or properly simulated weak-signal conditions. The latter is sometimes difficult to do on a local contact unless both parties in the QSO understand what objective is being attempted with the compressor. That objective, of course, is to raise the average power output of a transmitter. Thus, if tests are conducted under strong signal conditions with full rf gain control setting on the receiver being used to check the transmission, little or no variation in signal strength may be observed with the compressor in or out of the transmitter. This is because the receiver agc "washes out" the variations in received signal strength as heard aurally. Such a test should be made with the lc gain control on the receiver reduced to the minimum which will allow reception without the compressor used in the transmitter. When the compressor is inserted, a more accurate demonstration of its effect will then be obtained.

In some cases, the effect of using the compressor is readily observed at the transmitter. For instance, in the author's situation an HA-14 linear is used. The plates of the 572 tubes normally appear gray under operation without the compressor. Using the compressor, the plates develop a dull red color. This is due to increased average power input which certainly—assuming no audio distortion—means increased signal strength being radiated.

The increase in average power is difficult to determine exactly without complex instrumentation, but it seems to be in the order of 20 to 30 percent. This may not appear tremendous but, considering that only 4 dollars was invested, there would hardly seem to be any easier way to squeeze a bit of additional power from an existing linear.

The ways shown in this article to convert an inexpensive amplifier into a compressor are certainly not the only methods usable. A multitude of articles have used other methods. However, with a bit of care they can all be adapted to use an inexpensive amplifier as described in this article as a foundation since only the control circircuits are different but the basic amplifier stages remain the same. . . . W2EEY/1

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Reactance or Impedance?

A problem encountered by technical people for many years involves the two fleeting quantities known as impedance and reactance. One never really knows when reading an article or text which one is being discussed due to the ambiguity traditionally associated with these terms. Many publications presently in print speak freely of reactance as having a "phase angle", or impedance as being a simple number quantity. Both of these statements are totally incorrect.

Reactance is a term applied to a quantity having magnitude only with no regard to direction. Impedance, on the other hand, not only implies magnitude, but dictates a particular direction as well. The reactance of an inductor of 1 Henry being operated at a frequency of 60 Hz would be:

$$X_L = 2\pi fL = 2\pi(60)(1) = 377 \text{ ohms}$$

This quantity is called reactance and has a value of 377 ohms, with no consideration given as to direction. If at this point we say that our inductor has a value of 377 ohms at angle (direction) of 90 degrees, we have immediately bridged the gap and developed a new quantity called *impedance*.

Consider the following analogy: A bullet is fired from a rifle at a speed of 600 miles per hour. Only one correct deduction concerning the bullet may be made with the information given; namely, that it is moving fast enough to do physical harm. It would behoove those concerned to also know the direction of travel to avoid an early demise. In other words, the information conveyed by knowing both the magnitude and the direction is most beneficial. The same is true with reactance and impedance. Reactance conveys magnitude information only; impedance denotes magnitude and direction.

In order to manipulate these quantities from a mathematical standpoint, the concept of Complex Notation must be introduced. It should be immediately pointed out that the only thing complex about complex numbers is the name. This is mentioned to overcome mental blocks, which usually arise during the initial stages of development.

A complex number is represented by the sum of two numbers, one called the real part, and the other called an imaginary part. Since both real numbers and imaginary numbers are simply numbers which we use daily (1, 2, 3.9, 2.7, 19, 140.2, etc.), we must somehow distinguish between the two. In order to do this, we introduce the imaginary operator j, which acts as an indicator much the same as a flagman would in traffic. As an example, let us assume we have the complex number: $A = 3 + j4$. In this case, the real part of the complex number A is 3; while the imaginary part is 4. Note that the function of j is only to indicate that there is something "different" about the number 4.

Relating this concept to the realm of impedance, we note that, in general, impedance is also a complex quantity. The real part of impedance is called resistance denoted by the letter R. The imaginary part of impedance is called reactance and is symbolized by the letter X.

Let us now consider a circuit containing only an ideal inductor.

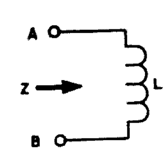

Fig. 1. A very simple inductive circuit. If the resistance is zero the voltage leads the current by 90 degrees and we say $Z = 0 + jX_L$ ohms.

It is the object now to determine the total circuit impedance looking into terminals AB. In the circuit shown there is no resistance (R), therefore, there is no real part in our complex number. The imaginary part of the impedance is the inductive reactance X_L. X_L may be found knowing the inductance (L), and the frequency (f) as was shown in a previous example. The total impedance is:

$Z = 0 + j\,X_L$ ohms, where j indicates the direction.

Since this quantity possesses both magnitude and direction, it is often more easily understood when illustrated graphically on a standard Cartesian Coordinate System. Our real axis is along the horizontal, while our imaginary is plotted vertically. By convention, always plot the real part first and then plot the imaginary in a tip to tail fashion, utilizing the previous example, plotting resistance first $R = 0$. Now add the imaginary portion to the real obtaining the value X_L plotted vertically on the imaginary axis.

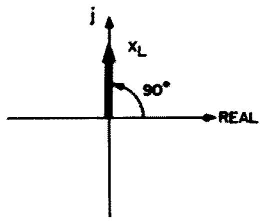

Fig. 2. Here we are saying $Z = 0 + jX_L$ ohms, graphically. The heavy arrow represents impedance. Its length indicates the value of the impedance, which we call reactance.

We will pick the horizontal axis to the right as being positive. All positive angles are measured with respect to this axis when moving in a counterclockwise direction. Returning to our example and measuring this angle with a protractor, we see it to be a positive 90°. The significance of this angle will be discussed later.

As a second example, consider a capacitor only, the impedance of which is to be determined. The reactance of the capacitor is given by:

$$X_C = \frac{1}{\omega C}$$

Now by definition we choose the capacitive impedance to have a $-j$ associated with it. Therefore, the capacitive impedance becomes $-jX_C$, and it is plotted on the graph previously mentioned, vertically downward as shown below:

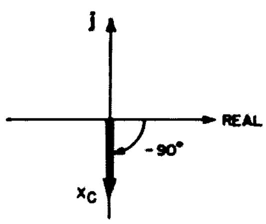

Fig. 3. If we replace the inductor of Fig. 1 with a capacitor, still assuming there is no resistance, the impedance arrow now points downward.

It can be seen by these brief examples that the j designation for the impedances save confusion when writing the values.

Let us now consider a combination of an R, L, C connected in series. It will be our objective to calculate the total impedance in both mathematical forms. Given the circuit in **Fig. 4:**

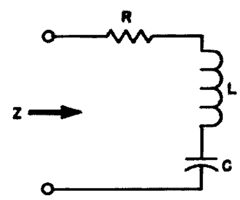

Fig. 4. Here is a more complex circuit. We might find this in a bandwidth-limiting application. What is its impedance?

The reactances of each of the components may be found by the usual manner, X_L and X_C. We will now determine the values of the individual impedances. The impedance of the resistance is the easiest, for it consists of a real part only, that is, $Z_R = R + j0$ ohms. The impedance of the capacitor is $Z_C = 0 - jX_C$ ohms, and for the inductor it is equal to $Z_L = 0 + jX_L$ ohms. Impedance in series add and, therefore, the total impedance is $Z_R + Z_C + Z_L = Z_T$ or $Z_T = R + j0 + 0 + jX_L + 0 - jX_C$ ohms. We can find the sum by adding the real parts and the imaginary parts separately. $Z_T = R + jX_L - jX_C$, but since the j term is common in this case, Z_T becomes $Z_T = R + j\,(X_L - X_C)$. This can be shown graphically by the following:

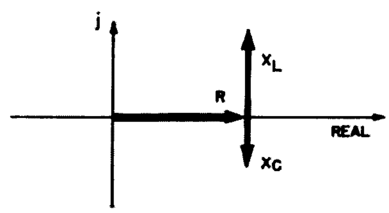

Fig. 5. First we must know the frequency. Then we determine impedance by adding resistance and reactance values graphically, or by math having the same meaning. Remember reactance will vary with frequency, changing the impedance.

Note that R was plotted first, then jX_L and $-jX_C$ in the tip to tail fashion described previously. jX_L and $-jX_C$ lie in the same plane, however, in the opposite direction. Therefore, the result of $j\,(X_L - X_C)$ can be found by algebraically subtracting X_C from X_L. The result X_T remains unchanged but X_T is now in the positive direction, this is because X_L is larger than X_C in this example.

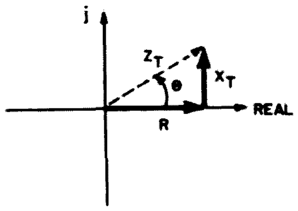

Fig. 6. Taking the difference between inductive and capacitive reactance, the inductive reactance wins this time. At some lower frequency they would cancel, leaving resistance only. And at a still lower frequency the capacitive reactance would predominate.

If the other case were true (X_L smaller than X_C), the result X_T would point in the negative direction. X_T and R form a right triangle and the line Z_T represents the hypotenuse of the right triangle. Using the theorem developed by Pythagorus which says that the hypotenuse of a right triangle is equal to the square root of the sum of the other two sides squared, the magnitude of Z_T becomes:

$$|Z_T| = \sqrt{R^2 + X^2} \text{ ohms}$$

which is the formula given in most handbooks. However, this is only half the picture; we still must have a direction. The angle θ on Fig. 6 can be found by the formula:

$$\theta = \arctan \frac{X_T}{R}$$

Read, theta is the angle whose tangent is $\frac{X_T}{R}$. Therefore, the impedance may be expressed in two ways:

$$Z = R + j\ (Z_L - X_C) \text{ or } Z_T \angle\theta$$

To summarize, let us now turn our attention to a numerical example. Consider an R, L, C series circuit being used at 60 Hz. The value of the individual components are as follows: R = 300 ohms, L = 0.5 Henrys and C = 10 microfarads.

Calculating the reactances:

$$X_L = 2\pi fL = 2\pi\ (60)\ (0.5)$$
$$X_L = 188.5 \text{ ohms}$$
$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(60)(1\text{x}10^{-6})}$$
$$X_C = 265.0 \text{ ohms}$$
$$Z = 300. + j\ (188.5 - 265.)\text{ ohms}$$
or $$Z = 300. - j\ 76.5 \text{ ohms}$$

See **Fig 7** for graphic illustration.

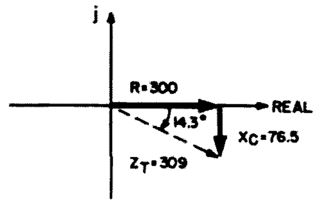

Fig. 7. Working out the circuit of Fig. 4. If we apply a 60 Hz current to this circuit we will find the voltage across its terminals lagging 14.3 degrees. Or if we trigger our scope from the voltage signal the current will appear to lead by the same 14.3 degrees.

$$Z_T = \sqrt{(300)^2 + (76.5)^2} = 309 \text{ ohms}$$

$$\theta = \arctan \frac{-76.5}{300} = -14.3 \text{ degrees}$$

The total impedance for this circuit is 309 ohms at an angle of −14.3 degrees.

The angle associated with the impedance in actuality represents an angular (phase) difference between the voltage applied to, and the current in the circuit considered. By definition, if the angle associated with the impedance is positive the voltage leads the current, and the circuit appears basically inductive. Similarly, if the angle is negative, as in the previous sample, the current leads the voltage, and the circuit appears to be predominantly capacitive. The special case of no phase shift occurring between voltage and current, (corresponding to an angle of zero degrees) simply indicates a purely resistive circuit.

On can at this point begin to appreciate the significance of the quantity impedance, and the enormous amount of information conveyed with it, as opposed to the simple quantity reactance.

Whether engineer, technician, serviceman or home experimenter, the blossoming age of electrical technology demands an understanding of the subtle distinction between these two very basic circuit concepts.

. . . K9ZPZ . . . K9DKB

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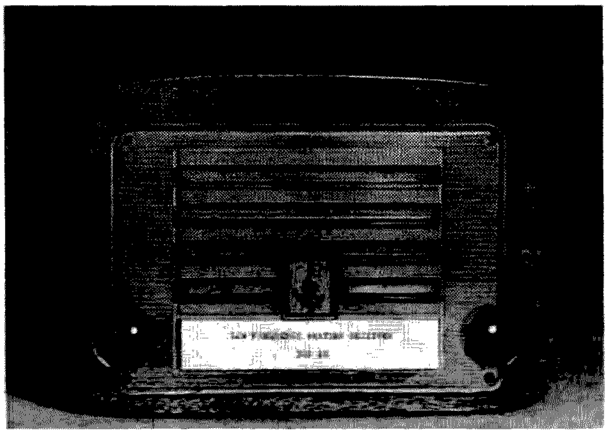
3154 *Jordan Road*
Oakland, California 94602



Of all the surplus receivers available, probably the easiest to come by, and most neglected, are the ac-dc broadcast receivers. They are not the most sophisticated, but certainly they are reliable. These receivers will give years of service.

Here is a conversion project that should take under a half hour, and give hours of listening pleasure. The conversion will give you a low, fixed frequency weather monitor receiver. The Federal Aviation Administration broadcasts reports for fliers, usually start at 5:00 A.M. and continue untill 11:00 P.M. There is a projected weather report and a current report that is changed hourly. Pick the weather station nearest to you from the list. You will hear the identification in MCW, below the verbal report.

Step 1. First, be sure the receiver is receiving the broadcast band normally.

Step 2. Disconnect the receiver from the ac source and remove the chassis from the case.

Step 3. Turn the variable capacitor to maximum capacitance (fully meshed) then solder the shaft to the frame, thus locking the variable capacitor. Use at least a 100 watt soldering iron.

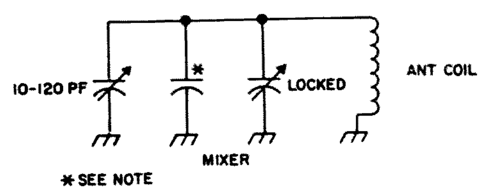
Step 4. Solder a variable capacitor, 10-120 PF, across the oscillator section. The oscillator section can be identified by the fact that it has the least number of plates. Solder the ground side of the capacitor to the frame of the original capacitor. The other terminal goes to the tab of the oscillator capacitor.

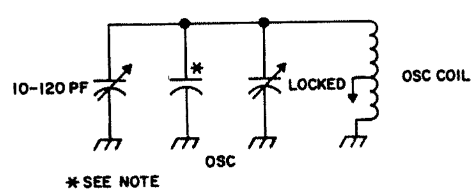
Step 5. Connect a fixed 300 pF* capacitor, plus a 10-120 pF variable across the converter section of the original capacitor. One side of the fixed and variable capacitors is soldered to the frame, the other sides are connected to the tab of the original capacitor. Connect a 10 mF 25-volt capacitor across the cathode resistor of the last stage of audio.

Step 6. Remember, all ac-dc receivers are dangerous to the point of being lethal when removed from their insulated cases. If you have an isolation transformer, now is the time for it; if not, check the polarity of the 115-volt plug, so that the chassis is not on the high side of the ac line (I would hate to lose you at this stage).

Step 7. Now with the set turned on, and the volume up, with an insulated tool, tune the variable oscillator capacitor until you hear the weather station. Now tune the converter variable capacitor for the loudest point.

Step 8. Remove ac power source. Install the chassis in case, be sure to use the original insulated knobs.





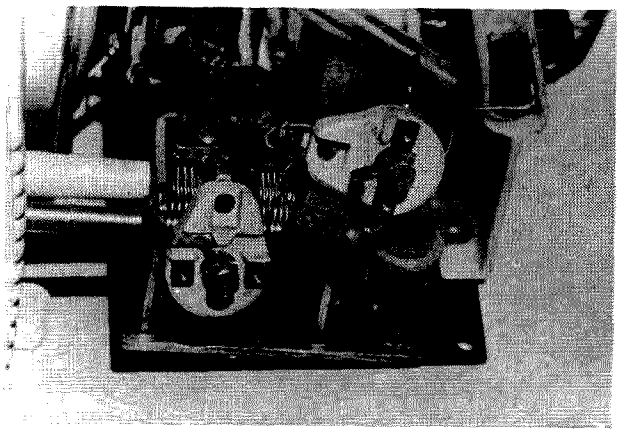
Note:
*For weather stations down to 350 kHz, use 300 pF capacitor across mixer capacitor.
For weather stations down to 295 kHz, use 650 pF capacitor across mixer capacitor.
For weather stations down to 220 kHz, use 1,400 pF capacitor, and in addition, use a 100 pF capacitor across oscillator capacitor at this low frequency.

Photos by Les Toth

Step 9. Conversion is now complete, and the receiver is as safe as it ever was.

True, we can do very little to change the weather, but at least we can keep informed and know what to do to prepare for it. ■

Airport Weather Report Frequencies As of 10-1-68

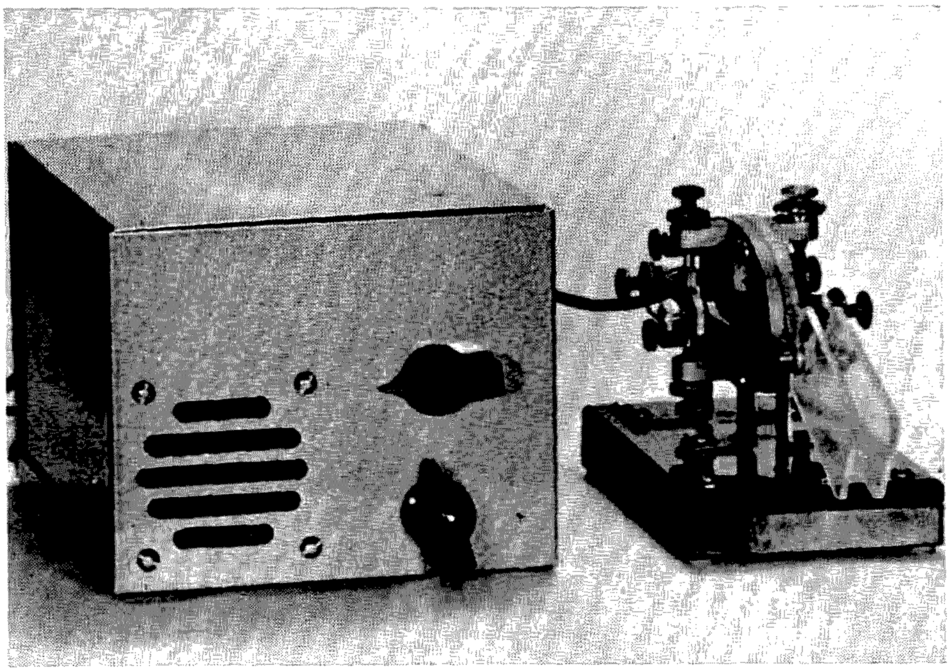


Alabama	
Birmingham	224 kHz
Arizona	
Phoenix	326 kHz
Tucson	338 kHz
Arkansas	
Little Rock	353 kHz
California	
Blythe	251 kHz
Fresno	344 kHz
Los Angeles Int.	332 kHz
Oakland	362 kHz
Colorado	
Englewood	379 kHz
Trinidad	329 kHz
Florida	
Jacksonville	344 kHz
Miami	365 kHz
Pensacola	326 kHz
Tallahassee	379 kHz
Tampa	388 kHz
Georgia	
Atlanta	266 kHz
Idaho	
Boise	359 kHz
Idaho Falls	350 kHz
Illinois	
Chicago	350 kHz
Indiana	
Indianapolis Muni	266 kHz
Kansas	
Garden City	257 kHz
Wichita Muni	332 kHz
Louisiana	
Grand Isle	236 kHz
Shreveport	230 kHz
Maine	
Millinocket	344 kHz
Massachusetts	
Boston	382 kHz
Michigan	
Detroit	388 kHz
Houghton	277 kHz
Sault Ste. Marie	400 kHz
Traverse City	365 kHz
Minnesota	
Duluth	379 kHz
International Falls	356 kHz
Minneapolis	266 kHz
Mississippi	
Jackson	260 kHz
Missouri	
Kansas City Intl.	359 kHz
St. Louis	338 kHz
Springfield Muni	254 kHz
Montana	
Billings	400 kHz
Bozeman	329 kHz
Great Falls	371 kHz
Missoula	308 kHz
(Johnson Bell)	
Nebraska	
Omaha	320 kHz
Nevada	
Las Vegas	206 kHz
New Jersey	
Newark Muni	379 kHz
New Mexico	
Albuquerque Sunport	230 kHz
Roswell Industrial	305 kHz
Air Center	
New York	
Elmira	375 kHz

North Carolina	
Raleigh - Durham	350 kHz
Ohio	
Cleveland (Hopkins Intl.)	344 kHz
Oklahoma	
Will Rogers World	350 kHz
Tulsa Intl.	245 kHz
Oregon	
Pendleton	341 kHz
Portland Intl.	332 kHz
Redmont	368 kHz
Pennsylvania	
Pittsburgh (Allegheny County)	254 kHz
South Carolina	
Charleston	329 kHz
Spartanburg (Downtown) Memorial	248 kHz
South Dakota	
Rapid City	254 kHz
Tennessee	
Knoxville	281 kHz
Memphis (Metro)	371 kHz
Nashville (Metro)	304 kHz
Texas	
Amarillo	251 kHz
El Paso Intl.	242 kHz
Meacham Field	365 kHz
Midland Odessa Regnl.	326 kHz
Utah	
Delta	212 kHz
Ogden	263 kHz
Vermont	
Burlington Muni	323 kHz
Virginia	
Roanoke Muni	371 kHz
Washington	
Seattle	362 kHz
Spokane Intl.	365 kHz
Walla Walla	356 kHz
Wisconsin	
Milwaukee	242 kHz
Wyoming	
Casper Air Terminal	269 kHz
Rock Springs	290 kHz

The Charmin' Keyer

Richard Schwanke W9HXM
235 Cumnor Avenue
Glen Ellyn, Illinois



Nowadays, if on operates CW without a squeeze keyer, he is not a member of the *in* group. The squeeze keyer presented here is, to the best of the author's knowledge, the first unit which will perform either of the two popular forms of squeeze keying.[1,2] When desired, it can be used as a conventional keyer. With a single lever, it has very agreeable timing and is rather forgiving of operator errors.

The circuit diagrams are presented. **Fig. 1** is drawn with NPN transistors and will be used in all of the rest of the article for discussion of logic. **Fig. 13** is drawn with PNP transistors for those with a large supply of PNPs and for those who would like to modernize a keyer circuit published in 1962[3] which has many of the same components.

It would have been much easier to design this keyer with integrated circuits, but the cost to noise margin ratio is much more favorable in the discrete component version.

1. Gensler, Harry, Jr., "The Iambimatic Concept," QST, Jan., 1967.
2. Moss, Jimmy, "The WØEPV Squeeze Keyer," QST, July, 1967.
3. Muir, Dave, "The Penultimate Electronic Key," QST, March, 1962.

Brief description

Fundamentally, this keyer consists of a dot generator with a binary counter which is used to fill in the spaces between two dots to form a dash. Several control paths are used. One path (R_{50}) controls the dot generator directly and combines with feedback from the output of the dot generator (R_{51}, D_{12}) giving self completion. A second path (R_9, D_2) sets the Dash FF enabling the binary counter via R_{43}. A reset signal is provided to the Dash FF via C_2, D_4 every time the relay opens. A third path (R_{53}, Q_{13}) sets the Dot FF if and only if the Dash FF is set. A fourth path (D_5, D_6, R_{21}) allows the Dot FF to be rest if and only if the Dash FF is NOT set thus providing Dot Memory. A fifth path (Q_{14}, R_9, D_1 R_{10}) prevents setting the Dash FF if the Dot FF is set or a dot is in progress. A sixth path (R_{18}, R_{24}) keeps the Dot Generator running when either the Dot FF or the Dash FF is set.

The final result of these controls gives a keyer which can remember one dot that was called for during a dash with no critical timing and will either give alternate dots and dashes when both dot and dash

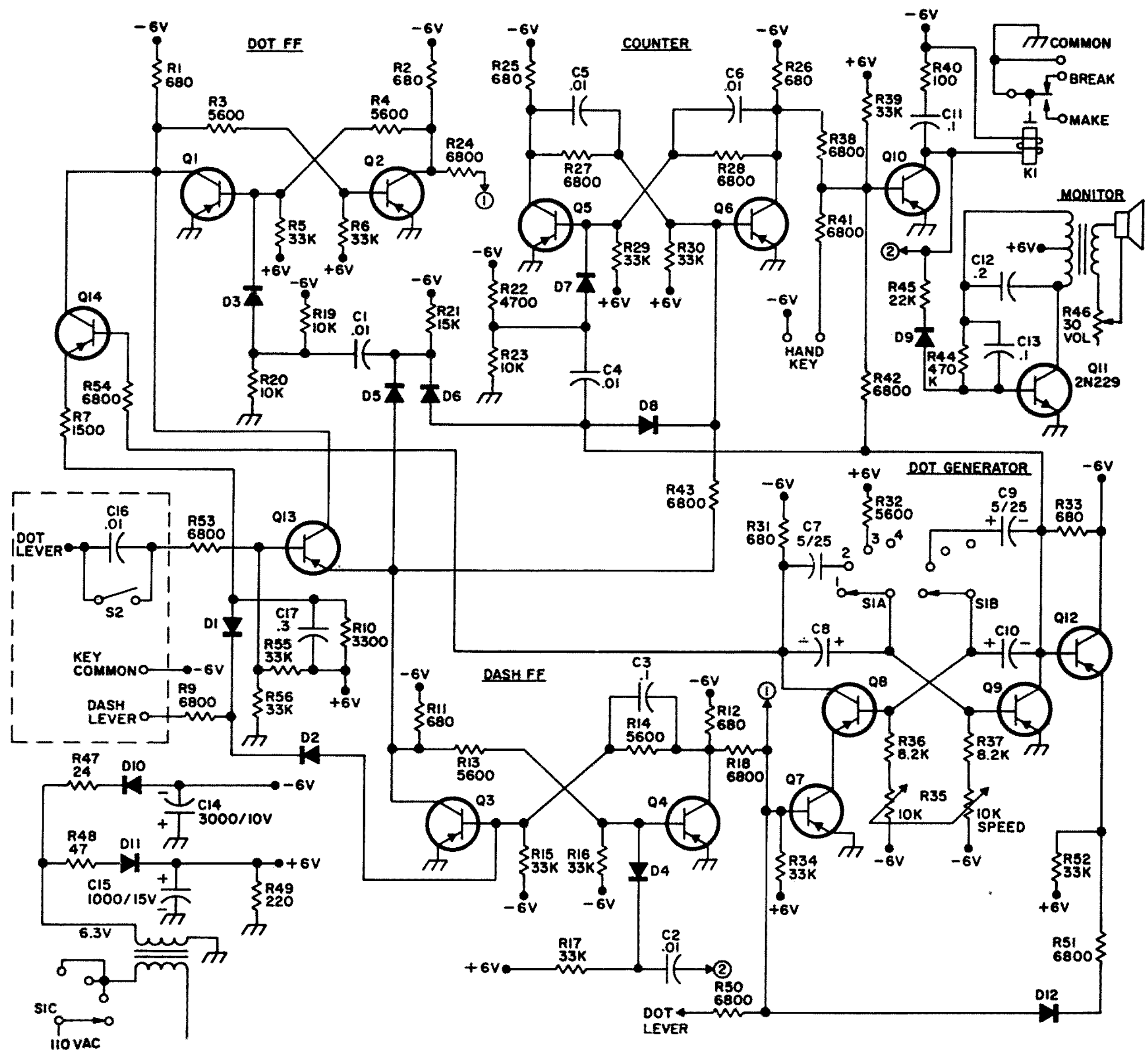


Fig. 1. Complete circuit using NPN transistors. K_1—500 ohm relay. Q_1-Q_{10}, Q_{12}-Q_{14}—NPN (2N2923). *Q_{15}—PNP* (2N4126). *D_1-8—Germanium* 1N90. *D_9—Silicon. D_{10}-$_{11}$—Silicon* 50 *PIV*, 100 *mA. S_1*—3 *pole* 4 *pos. rotary switch* (*Mallory* 3134*J*). *S_2—SPST.*

levers are held or insert one dot in a string of dashes. The use of two independent key levers which may be squeezed to produce additional combinations is required to realize all of the potential benefits.

When switch S2 is closed, a squeeze will produce a continuous string of alternating dots and dashes thus making characters such as C and AR almost effortless. The timing required by the operator is very uncritical and one need only follow the instructions on the chart (**Fig. 2a**) supplied to learn the new technique in one or two evenings.

If switch S2 is opened, the operator will feel as though he has an entirely different keyer and a chart (**Fig. 2b**) shows the details of the second technique which the author calls single dot insertion (SDI). With SDI, one and only one dot will be produced during any single squeeze.

Alert readers (and those who have already studied the charts) have figured out that one set of characters is very easy with the alternating option, and an entirely different group is very easy with the SDI option. It is believed that this is the first

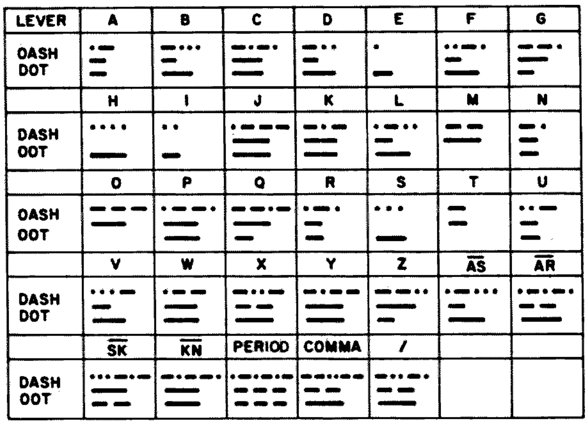


Fig. 2A. Keying chart (S2 closed). Alternate dots and dashes with dot memory.

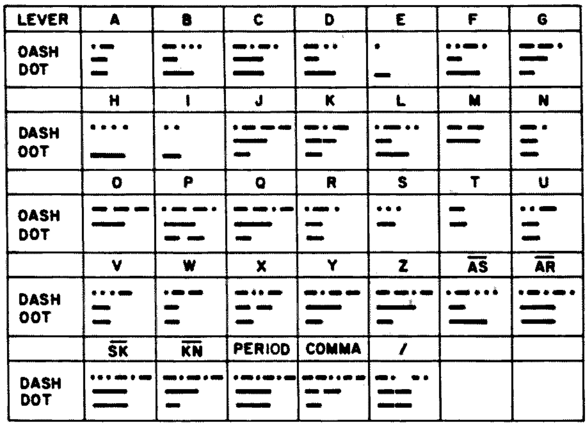


Fig. 2B. (S2 open) Single dot insertion.

published design where the operator can try both methods and make an intelligent choice after he has spent his money instead of tossing a coin beforehand and later being sorry. He can even change his mind years later at no additional cost.

Numerals are not listed in the charts as they are merely extensions of J, V, B, and G. The keyer will operate in the conventional way with a single lever while retaining the advantages of DOT MEMORY.

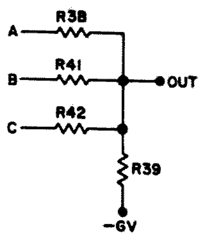


Fig. 3. Resistor OR circuit.

Theory of operation

The circuit presented here, while somewhat complicated in appearance, is a collection of basic logic circuits each consisting of a small number of elements. In **Fig. 3,** a resistor OR circuit is shown. If any of the inputs (A, B, or C) is UP (True), then the output is UP. If all of the inputs are DOWN (False), then the output is DOWN. Nothing more complicated than a voltage divider with low resistance input resistors and a high value bias resistor is needed to accomplish this function. The resistor OR is used to turn on the clock and for combining the clock and binary counter in the base of the relay driver.

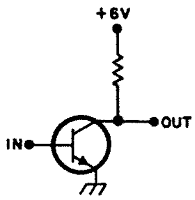


Fig. 4. Transistor inverter.

Fig. 4 is a transistor inverter of which there are ten used in this keyer. When the input is UP, current flows in the base-emitter junction causing a much larger current to flow in the collector-emitter junction and thus through the collector load resistor. The amplification of current is important and must not be forgotten, but the most important point in this discussion is that when the input is UP, the output is DOWN, Thus inverting the signal. This is commonly referred to as the NOT function. Combining the resistor OR with the transistor NOT forms a logic block called a NOR circuit which will not be treated further here.

When the output of one Inverter in **Fig. 5** is used as the input to a second Inverter and the output of the second is used as the input to the first, a FLIP-FLOP is formed. A FLIP-FLOP can be thought of as a teeter-totter, a long board with its center of gravity somewhat above its pivot point such that it will stay on one side or the other but is unstable in the transition. The FLIP-FLOP is also called a bistable multivibrator and is used for temporary memory. For example the DOT FF remembers a dot to be generated and the DASH FF remembers a dash is in progress.

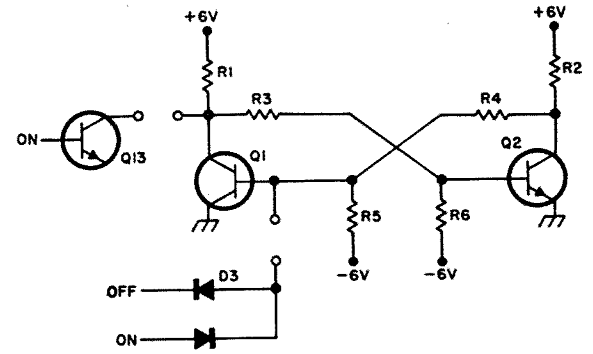


Fig. 5. Bistable Multi-Vibrator Flip-Flop.

A FLIP-FLOP can be made to change states by 1) pulling down on the collector of the off or UP side (Q_{13}), 2) forcing the off transistor on at its base (R_{43} and R_9, D_2), or 3) forcing the on transistor off at its base (D_3). Emitter triggering is not used here.

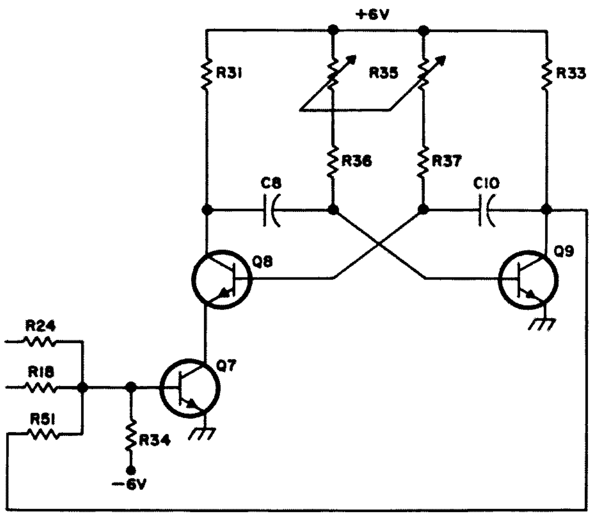


Fig. 6. Astable Multivibrator

The astable multivibrator in **Fig. 6** is similar to the FLIP-FLOP except for the feedback paths which are primarily (or in this case entirely) ac instead of dc. The astable multivibrator will change quickly from one side to the other and remain as long as the charge on a coupling capacitor holds one transistor off. When this charge finally bleeds to a small enough value, the OFF transistor will turn on and, through the other coupling capacitor, force the formerly ON transistor off. The result is a regular oscillation which is square wave in nature. Observation in an oscilloscope (**Fig. 7**) shows that the transition from UP to DOWN is much faster than the transition from DOWN to UP and is more useful for forming pulses.

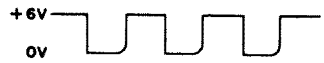


Fig. 7. Waveform at Collector or Astable Multivibrator.

In this circuit, as astable multivibrator is used as the main clock and DOT generator. Such an oscillator may be turned on and off with predictable results by inserting a transistor inverter (Q_7) between one emitter and ground thus serving as a switch. Once started, completion of one cycle can be guaranteed by using the output of the oscillator (with proper polarity) as one of the inputs to the OR gate controlling the switch (Q_7).

When loading becomes a problem, it is sometimes necessary to use an emitter follower which will enable driving many more circuits than a FLIP-FLOP alone or an oscillator alone can handle. This device is used on the oscillator (Q_{12} in **Fig. 1**).

Pulses can be obtained from a square wave by differentiating in an RC network where the pulses can be given a suitable dc base line by choice of voltages and resistors as shown in **Fig. 8.** The positive or negative going pulses may be selected by means of diodes. Time can be changed one half cycle by using the other side of the oscillator. Pulses from the oscillator are used to trigger the binary counter and, with suitable gating, reset the DOT FF.

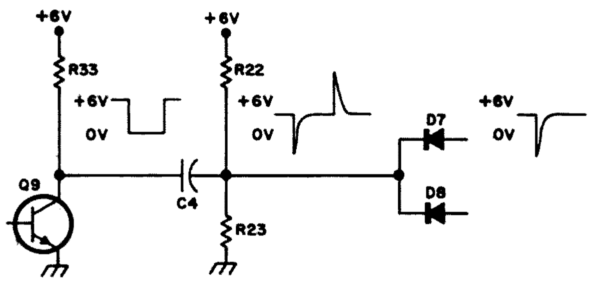


Fig. 8. Pulse formation and selection from a square wave.

A two transistor AND circuit with inverted output is shown in **Fig. 9.** This is commonly called a NAND logic block. When the inputs to both transistors are UP, the output is DOWN thus setting the DOT FLIP-FLOP shown in **Fig. 1** since R_1 is common to both circuits. The DOT **FF** is set if and only if the DASH FF is set.

There is one other feature worth noting here. All FLIP-FLOPS (or multivibrators) have two outputs. When one of these is

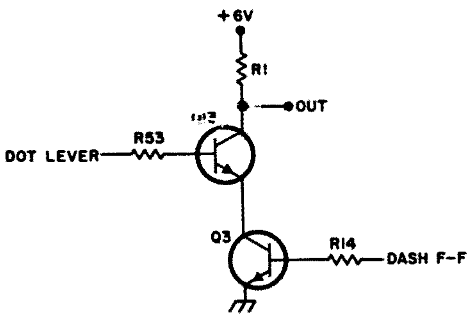


Fig. 9. Transistor NAND.

arbitrarily called True (UP) then the other output must be False (DOWN) and is referred to as the complement of the chosen output. A bar over the signal name is the usual notation for the complement of a signal.

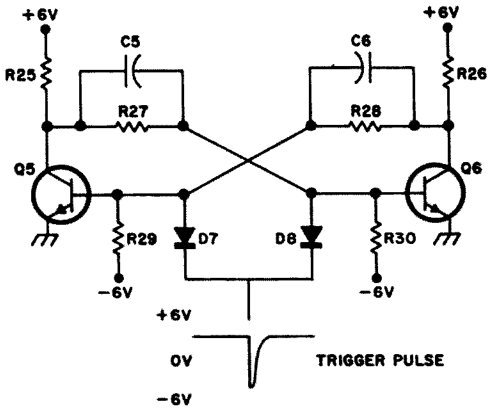


Fig. 10. Binary Counter.

Fig. 10 shows a FLIP-FLOP with steering diodes added such that it will operate as a binary counter by changing state every time a pulse comes along. The pulse duration, amplitude and polarity are selected so that whichever transistor is ON will be turned off. (Obviously the transistor which is OFF will not be affected by this pulse). As the ON transistor is turning off, the voltage at the collector rises rapidly so that a new pulse is ac coupled to the base of the OFF transistor thus turning it on. Due to the rc constants used and the delay between the first and second pulse, the second pulse will be larger than the first and will be definitely in control when it arrives. The binary counter fills in the spaces between the dots when combined with the clock in an OR gate, thus forming a dash.

One very unusual device used in this circuit is the inductive kick which occurs whenever the current flowing through an inductance such as a relay coil is stopped suddenly. **Fig. 11** shows the circuit and the voltages seen at three points in the circuit. This pulse is used to reset the dash FLIP-FLOP.

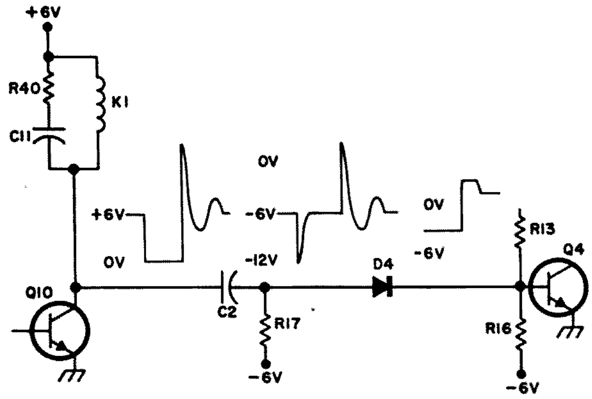


Fig. 11. Waveforms in Dash F-F reset circuit.

It is necessary that the DASH FF can not be set any time a dot is in progress or being remembered. **Fig. 12** shows the solution. Q_{14} and R_{54} form an OR gate with negative logic. Only when A and B are both UP can an UP at Dash turn on Q_3 If either A OR B are DOWN the DASH signal goes through D_1 and R_{10} to —6V and Q_3 is unaffected. D_1 and D_2 form an AND gate.

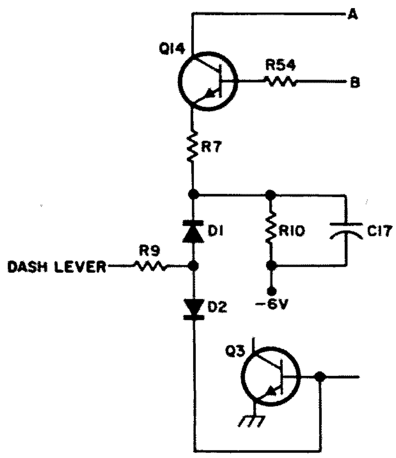


Fig. 12. Dash F-F-Set circuit.

Components

The circuit design presented here is not tied to any particular transistor number or category. The chances are very good that

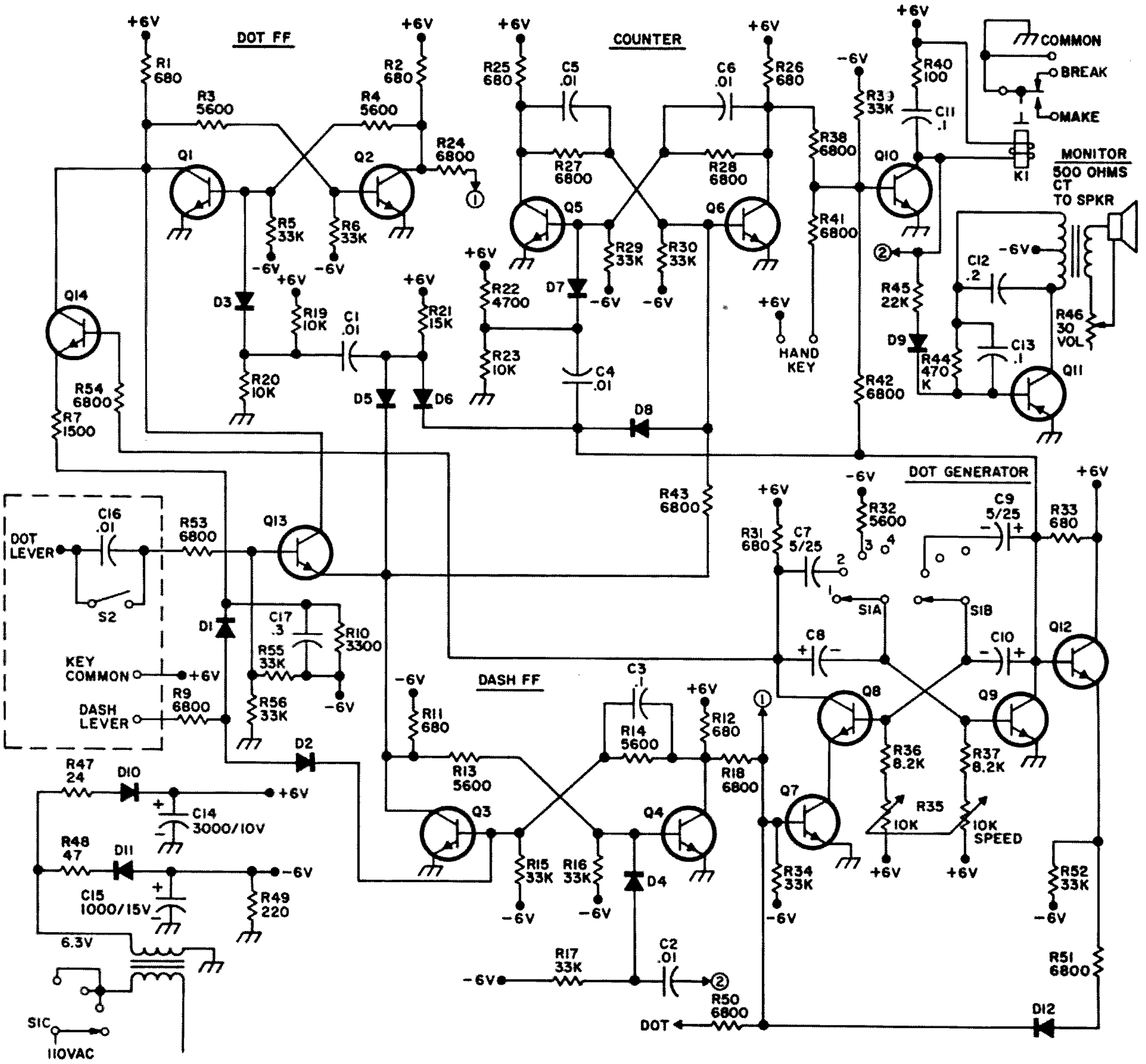


Fig. 13. Complete circuit using PNP transistors. All parts values same as Fig. 1. except $Q_{1\text{-}10}$, $Q_{12\text{-}14}$ are PNP (2N363), and Q_{11} is NPN (2N227).

components removed from old computer circuit cards can be substituted directly. Even though the voltages were different and the collector load resistors and base resistors are different, the chances are excellent that they can be used. However, it is a good idea to observe the relationship of the collector load resistors to the base resistors and the back biasing resistors in **Fig. 1** and not depart widely from these ratios.

There are a couple of areas where trouble can occur. Old germanium transistors have a tendency to get just a little bit sick, and thus erratic, but not sick enough so that they can be spotted easily. If you plan to use anything doubtful, it is a good idea to install sockets so that substitution is not a chore. The inductive kick in the relay circuit is surprisingly large so that a good healthy transistor is in order here.

It is recommended that a rough check of the gain and leakage be made if nothing is known about the transistors to be used. Leakage is a measure of the collector current with several volts applied and the base open and should be almost undetectable on a 1 mA meter. Gain is only a little more difficult. Assuming a 6 volt supply, choose a 300 ohm collector load resistor so that 10 mA will give a 3 volt drop across the resistor. Now find a base resistor which will cause 10 mA to flow at the collector and calculate the base current. The ratio of collector current to base current is an approximation of gain when leakage is low and must be at least 20 (much better 40). A pair of transistors used in a flip-flop should be within 25% of each other for ultra-reliable operation although no problems have been traced to this source.

Almost any germanium signal diodes can be used. (Silicon diodes should also be useable but have not been tried.) Germanium diodes will have a forward voltage drop of about 0.3 volt with a few ma flowing while silicon diodes will have a forward drop of 0.6 volt and will usually be painted black to eliminate the photo diode effect. Check the back resistance which should be at least 200 k ohms.

A reed relay is recommended for reliable, quiet high speed operation. However, there are some more economical types which are quite reliable at speeds below 30 wpm. If the relay is a little too slow it will give short dots. This can be fixed by unbalancing the oscillator to compensate. (R_{36} or R_{37} in **Fig. 1** may be reduced to 4 k ohms for balancing purposes. Do not go below 4 k oms or excessive base current will result).

If high gain transistors are used in the oscillator, a greater speed range can be obtained with a larger valued dual potentiometer. The upper speed limit can be raised by using smaller capacitors. The components

listed will go from 5 to about 40 wpm.

The power supply voltages are not critical except that the positive and negative voltages should be nearly the same and if much different from that required by the relay, a dropping resistor may be needed somewhere to make things work out right. R_{47}, R_{48}, and R_{49} may be altered to adjust the positive and negative voltages. It is most important that power supply ripple be within reason or a phenomenon known as collector triggering will cause erratic timing in the dot generator. This is unlikely to happen with the components listed unless the electrolytic capacitors are defective.

Construction

The author has built many circuits of this type on perforated phenolic board with completely satisfactory results. The kind with closest spacing of the holes will allow a considerably smaller package. Eyelets can be very helpful if a setting tool is available, otherwise use flea clips or other push in terminals as needed.

This particular circuit has also been built on a printed circuit board which was laid out to accept a wide variety of economical components in either the PNP or NPN configuration.

Getting it to work

Before installing Q_7, use a voltmeter as an indicator with a probe on one of the collectors of a FLIP-FLOP while applying a 6.8k resistor from V_{cc} (+6V) to first one base and then the other base. The output should remain high or low depending on which transistor base was last touched. This test should be used on the DOT FF, the DASH FF and the COUNTER. Any of these that do not work should first be checked for wiring and then for components.

Next, hook up Q_7, the transistor controlling the oscillator. The output of the oscillator should be down. Now closing the dot lever should make the oscillator start. A voltmeter at the oscillator output should average half the supply voltage. An ohmmeter applied to the relay contacts should vibrate near half scale. If not, look for wiring errors or faulty parts in the relay driver. The oscillator should also operate when the dash lever is held. If not, look to see if the Dash FF is being set and if it is properly connected to the transistor controlling the oscillator. An ohmmeter connected to the relay contacts should now read about three quarter scale. If it still reads half scale, the counter is not working. Check wiring and then components. Make sure the counter is connected to the relay driver.

The dots and dashes should stop when the levers are released. If the dots fail to stop, check the emitter follower on the oscillator and the resistor and diode going to the control transistor. Also check for reseting of the Dot FF. If the dots work OK but the dashes will not stop, the most likely cause is in the components going from the collector of the relay driver to the Dash FF. Look for the diode to be in backwards or routed to the wrong base. Try changing C_2 to .02 mfd.

Now the squeeze feature can be checked. Set the keyer at its lowest speed and hold the dash lever closed. Tap the dot lever at random times. A dot should occur between two dashes each time the dot lever is tapped. If errors occur, the Dot FF is not being set. Check the wiring to the Dot FF. With S_2 closed, holding or squeezing both levers should cause alternate dots and dashes. With S_2 open, holding both levers should cause one and only one dot and a string of dashes. The specific location of the dot will be determined by the precise time the dot lever was closed in relation to the dash lever.

It is quite probable that the monitor note will be rough or the wrong frequency. Improvements can be had by experimenting with R_{44}, C_{12}, and C_{13}. If a sine wave is achieved, it will likely be accompanied by chirp which is also annoying. The monitor is a compromise as it does not contribute anything to the keyer operation and a better one would cost considerably more.

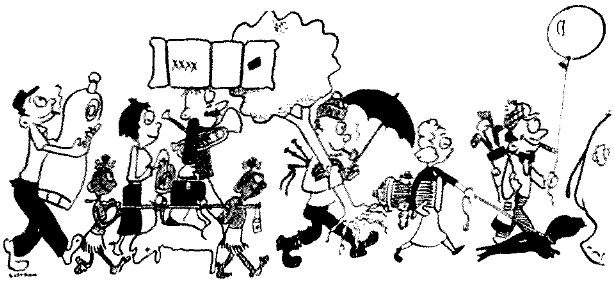
In one of the early models built with transistors of unknown quality, erratic operation was traced to low gain of Q_3 Thus it is suggested that the highest gain transistors be used at Q_8 and Q_9 while the next highest gain be used at Q_3 If new silicon transistors are used, no selection should be needed as the lowest gain likely to be supplied is more than adequate.

Conclusion

It is believed that many good circuits have fallen into disuse because they have some

minor defect when it would be quite profitable and satisfying to rework one of them to meet current requirements. The keyer presented in this article is completely new in its philosophy, logic, and timing, yet is was created from a 1962 model[3] by the deletion of one part and the addition of twelve new ones at a cost of less than three dollars.

Those who build the CHARMIN' KEYER will soon become unhappy with older keyers including some that cost twice as much and they need have no worries about operating close to a high powered linear. . . . W9HX



Moving? Please Let Us Know!

Amateur Radio Knows No Borders

Last fall, when Wayne Green and his wife, Lin, were vacationing in Europe, they met Fernand Dubret, HB9PJ, of Geneva, Switzerland. Mr. Dubret told them of his role as an amateur radio operator in saving the life of a Polish child who was dying of Wilm's tumor, a malignant tumor of the kidney.

Recently, Mr. Dubret sent his personal account of his arranging to send requested medication across the iron curtain. With his account were several photographs, and copies of congratulatory letters from the Polish Ambassador in Geneva, and from the International Amateur Radio Club. The material presented is based primarily upon his account.

On February 24, 1968, at 4:00 p.m. Fernard Dubret, HB9PJ, a French citizen who lives in Geneva, received a distress message on 14080 Kcls from SP3AUZ, Julius Schmidt, of Poland.

"CQ HB, CQ D, CQ G Medical SOS Mayday Please help for a dying four year old Polish child. We need within 24 hours a rare drug called Cosmegene from Firma Merck and Döhme. Please send the drug to Nowa Sol, Poland, immediately, please help."

Immediately, Mr. Dubret, who is an official with the International Telecommunications Union, responded and began to seek assistance from several doctors who were on call (some who were unfamiliar with the drug), and from several pharmacies, which were

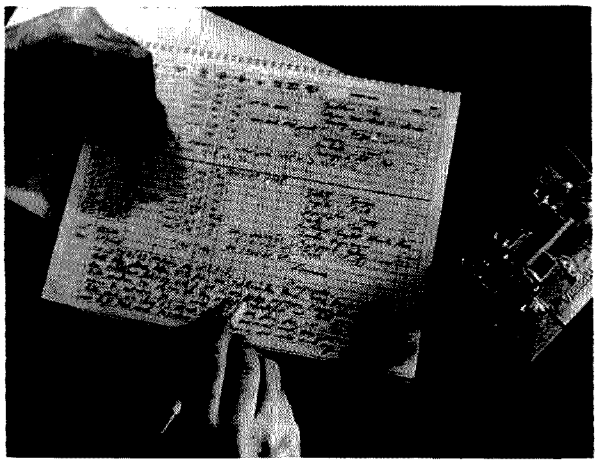


Photo of the Log at HB9PJ recording the incident.

Fernand Dubret HP9PJ. In his shack near Geneva, Switzerland.

Julek Schmidt, SP3AUZ. In Poland.

Marek in his hospital bed prior to the injection of the drug.

unable to supply the medication without a prescription. He alerted the Red Cross. He telephoned airports in Switzerland, France, and Germany seeking a plane which would be able to transport the drug once it was obtained. He discovered that the last flight from Switzerland to Poland would leave in an hour, so he alerted the Swiss police to arrange rapid transportation to the plane. By 5:30 Dubret had been unable to locate the drug, so he called the newspaper "La Swisse" where reporter, Raoul Reisen, responded to the request for assistance in obtaining the drug. Riesen called several pharmacies, and finally he called the pharmacist of Geneva Hospital, Albert Rochat, at his home. Arrangements were made to supply the drug from the hospital, but first it was necessary to contact SP3AUZ once again to obtain additional information regarding the exact chemical composition of the medication in relation to the age of the child. Within fifteen minutes of finding the drug, contact was made with Nowa Sol. SP3AUZ, Julius Schmidt, telephoned the hospital at Zielna Gora, which was twenty kilometers from Nowa Sol. Twenty minutes later, under conditions which were very difficult: static, interference, changing propagation, the formula was on the desk of Dubret. Contact had finally been reestablished on a different frequency.

By 6:15 p.m. the medication was ready. Unfortunately, the last flight to Poland, which had been held until the last possible moment, had just taken off.

Dubret immediately instigated another search for a flight to Poland; again reporter Reisen assisted. This time the Public Relations Department of Air France responded. Two stewardesses from Geneva and two at Orly were requested to deliver the medication from Geneva to Paris, and to the crew of Flight 724: Paris, Varsovie, Moscow. By 9:00 p.m. the packet was enroute from Geneva to Paris, and by 9:00 a.m. Paris confirmed that the medication was on its way to Poland.

Because of the difficulty in delivering the drug across the iron curtain Dubret had called the Polish Delegation assigned to the United Nations in Geneva, requesting their support in the safe delivery of the drug. The Delegation sent telegrams to the ambassador from Poland in Paris, and to the ambassador in the USSR. Dubret was

Dr. Kuchincki who saved Marek by diagnosing the illness and ordering the drug.

Railway station at Zicklova Gora, where the drug was passed from the engineer to Marek's father.

Hostess Amik Renouf giving the medicine to a member of Swissair to be flown to Geneva.

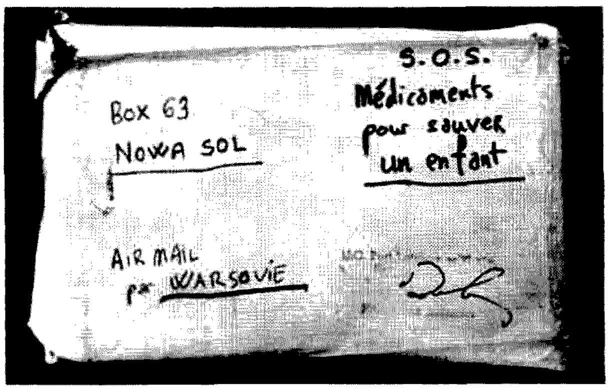
assured that the pilot of Flight 724, who would make only a short stop at Varsovie, would be authorized to leave the medication.

Between 10:00 and 11:00 a.m. Dubret broadcast to radio amateurs in Varsovie requesting that they go to the airport. (He also alerted amateurs in England and Sweden, for their propagation toward Poland was much more favorable.)

At the airport in Varsovie the response was amazing. There were numerous volunteers and well-wishers awaiting the arrival of the packet, eager to be of assistance. When the medication arrived, radio amateurs took charge, sending one part by police car, and another by train where it was entrusted to the engineer. Thus the medication was rushed from Varsovie to Nowa Sol.

By 2:00 p.m. Dubret had learned that the delivery had progressed as planned; and by 6:00 p.m. Polish amateurs informed him that the child, Marek Maziarz, had received his first injection within one hour of the appointed critical time. The medication was scheduled to be administered at regular intervals thereafter.

The next day while he was at work, Dubret received the news that the attending physician had stated that "without the Cosmegene, which arrived in time, I would have been able to do nothing; now the child will be saved." Following this the child's father thanked Dubret personally by radio and informed him that Maziarz, himself, had received one packet of medication from the engineer of the Varsovie - Nowa Sol express. Dubret received a report on the child's progress from the father. The child is now alive and healthy. ■



The original packet containing the drug. This package is now kept as a souvenir in the hospital where all say that Marek was saved thanks to radio amateur network.

The Polish group consisting of SP3CW, SP3AUZ, SP3BES, with Marek's father, Eugen Maziarz.

Marek after his discharge from the hospital fully recovered.

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A Better Balanced Modulator

Balanced modulators have been a vital part of amateur transmitters ever since development of interest in single-sideband. Although improvements have been made from time to time, most circuits still require resistive and capacitive balancing by means of adjustable elements. Unfortunately, the long-term and temperature stability of this approach is dependent on the characteristics of the pots and trimmers used. Temperature effects can be minimized by use of compensating elements but the whole process now becomes very involved. Circuit unbalance means not only carrier leak but greater distortion for a given audio input. The purpose of this article is to provide an introduction to a circuit capable of providing the same order of carrier rejection as conventional modulators with much better temperature and time stability. It can do this with absolutely no initial or routine maintenance type adjustments.

I claim no originality for development of the basic circuit since it is widely used in industrial and military equipment. All measurements performed and the resultant data were done by myself in the process of implementing the circuit in a home project.

The circuit shown in **Fig. 1** can be recognized as a ring modulator whose operation is adequately described in the literature[1]. T1 and T2 are usually wound in trifilar form on toroidal ferrite cores since this provides close coupling and more uniformity than other types of construction. Randomly selected diodes will provide about 15 or 20 db of carrier suppression below the double-sideband output. This figure can be increased to about 30 db at *if* frequencies with careful matching of the diodes. It is soon evident to the experimenter that any further improvement can only be obtained by the addition of balancing adjustments. The reason for this threshold is a basic limitation of the trifilar winding coupled with the method used for driving the transformer. Due to the single-ended input, one side of the secondary has more capacity to ground than the other. This unbalanced capacity has increasing effects as the operating frequency is raised.

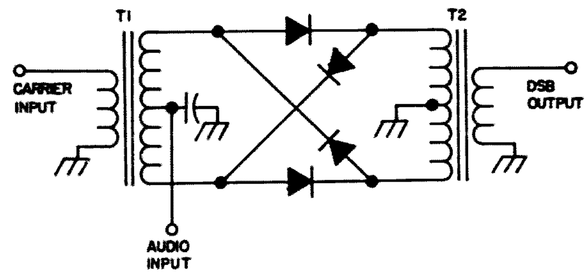

Fig. 1. Conventional ring modulator.

The easiest way to neutralize the effect of this unbalanced capacity is to isolate the return side of the primary from ground. This can be done by the arrangement shown in **Fig. 2.** T1 is a bifilar wound transformer with unity turns ratio which serves to isolate the primary return to T2. It may not be immediately obvious, but there is no loss of power in this transformation. The requirements that must be met are that the turns ratio be unity and the coefficient of coupling must approach unity. The mathematics used to prove this are not presented here since they are not common knowledge to most amateurs. The above requirements can be realized by the use of a bifilar winding on a toroid core.

The complete schematic of a practical modulator for use in the range of about 2 to 30 MHz is shown in **Fig. 3.** No tuning is used since T1 through T4 are broadband in nature with the impedance levels shown.

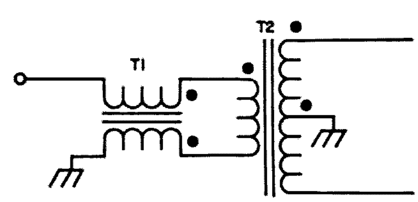

Fig. 2. Method of reducing effect of unbalanced capacity to ground in T2. Dot markings are explained in Fig. 4.

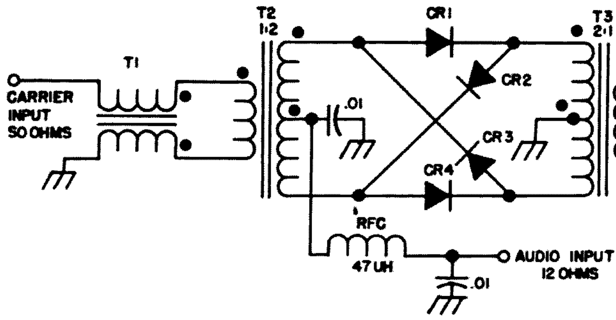

Fig. 3. Schematic of the wideband balanced modulator. The dots indicate winding polarities. Bifilar and trifilar winding is discussed in the text. Coil data: T1, T4-20 turns #32 enamel bifilar wound on 0.23 inch o.d. Ferrox cube toroid core (3D3 type ferrite). T2. T3- 30 turns #32 enamel trifilar wound on same core as T1 and T4. CR1, CR4- hot carrier or high speed silicon diodes.

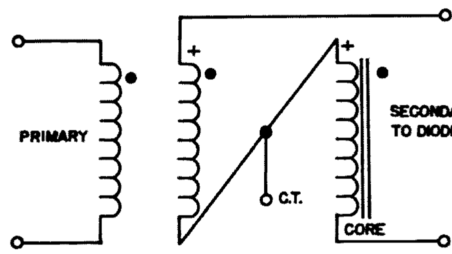

Fig. 4. Detailed illustration of the trifilar transformers, showing hookup of the three windings. The dots indicate that a current entering the primary in the direction shown will induce positive voltages at the ends of the secondary windings marked by the dots.

When terminated with a 50 ohm load at the output, the impedance looking into the carrier input is 50 ohms. With 1 volt rms of carrier injection, the impedance at the audio input is approximately 12 ohms. From the impedance levels it can be seen that this circuit is suited to transistorized circuitry but can be adapted for tubes.

Measurements were made at frequencies of 3 and 9 MHz, corresponding to the usual range of *if* frequencies used in amateur equipment. Equipment used consisted of an HP-606 *rf* generator, wto HP-200CD audio generators, an *rf* millivoltmeter, an *af* millivoltmeter, and a Singer spectrum analyzer. Optimum carrier injection at both frequencies is about 1 volt rms. Optimum audio level at this point is about 200 millivolts rms total (140 millivolts per tone for a two-tone signal). At 3 MHz, these operating conditions result in a double-sideband output of 137 millivolts rms with the carrier suppressed by 52 db below either tone. Intermodulation distortion is better than 50 db down. At 9 MHz, DSB output is 130 millivolts rms with a carrier suppression of 45 db and IM rejection of better than 50 db. At 30 MHz these figures will be degraded by a few db. High frequency performance can be improved by using fewer turns on the transformers. A higher carrier level will result in lower distortion but less carrier suppression. Less carrier injection will have the opposite effect. The figures given above seem to be a good compromise.

For those interested in using the circuit, a few construction hints are in order. It should be evident that the circuit can be stuffed into a very small space and hidden on a printed circuit board or in a corner of a chassis since no access to it is needed. An unclad epoxy board should be used to minimize unbalanced coupling to ground. The circuit layout should be symmetrical. Actually, the schematic gives a good physical layout and was used in the experimental unit. T1 and T2 should be placed at electrical right angles to eliminate mutual coupling. The same goes for T3 and T4. The close proximity of the cores makes this necessary as will become evident to anyone who experiments with the position of the cores while monitoring the carrier suppression.

The bifilar winding is formed by taking two pieces of wire, each of sufficient length to wind the required number of turns on the core, and twisting them together to form a twisted pair. This composite wire is then wound evenly around the core. The trifilar winding is exactly the same, except a third piece of wire is added to form a twisted triple. Referring to **Fig. 3**, 20 turns bifilar wound actually means 10 turns of a twisted pair. Similarly, 30 turns trifiler wound means 10 turns of a twisted triple.

The diodes should be matched by choosing

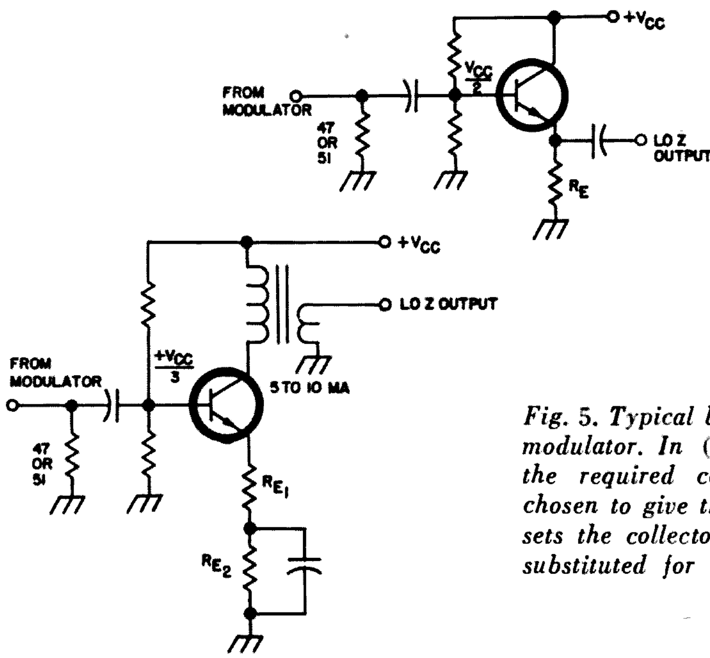

Fig. 5. Typical buffer amplifiers for terminating the modulator. In (A), Re should be chosen to give the required collector current. In (B) Re_1 is chosen to give the required voltage gain, while Re_2 sets the collector current. A tuned circuit may be substituted for the broad-band output tranformer.

those with the closest forward resistances on the XI ohms scale of a VTVM or TVM. Those with lower forward resistances are better from an efficiency standpoint. Most any silicon diode will have much higher back resistance than is necessary for proper operation. The zero-basis capacity is a more important consideration and should be no more than a few picofarads. The lower the better. Germanium diodes should not be used since their characteristics are not suitable for use in this circuit as regards efficiency and distortion. Hot carrier diodes have proven themselves more desirable at the higher frequencies. Another good choice for the diodes would be the RCA CA3019 which is an integrated circuit diode array. The advantage of using a unit like this is the excellent matching and temperature tracking of the diodes.

The modulator can be unbalanced by inserting a variable dc voltage of 0 to about ±1.5 volts at the audio input. This should be fed through a choke of 200 mH or more to avoid disturbing the audio frequencies. It is also worthwhile to mention that the load resistance at the output terminal should be kept in the vicinity of 50 to 100 ohms for proper operation with the circuit constants shown. Probably the most reliable way of obtaining a constant 50 ohms is by shunting the output with a 50 ohm resistor and using a buffer amplifier. **Figs. 5a** and **5b** will illustrate.

This circuit is not limited to use as a balanced modulator. It functions very well as a low distortion product detector by adding a step-up transformer at the audio terminal to bring the impedance level up to 10 or 20K ohms. With an *if* input of about 100 millivolts rms, a few volts of audio will be pro-

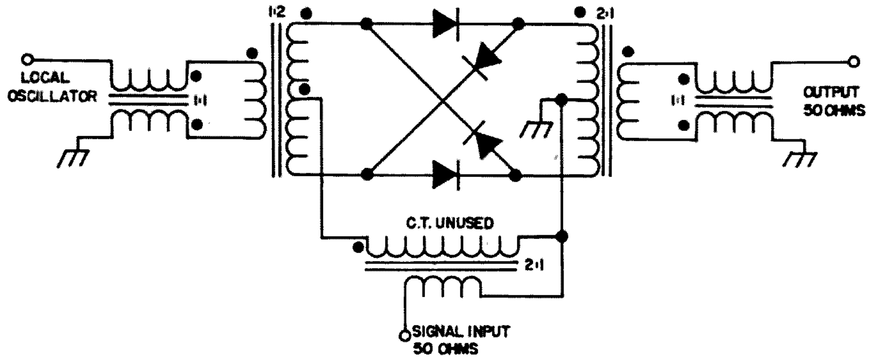

Fig. 6. Wideband balanced mixer. Transformers and diodes are the same as in Fig. 3. Signal levels should be the same as for balanced modulator service.

duced at the secondary of the matching transformer. This can be fed directly into a power output stage using a pentode. A lower step-up from the detector should be used for a transistor output stage. The dynamic range of this detector is on the order of 130 db. The addition of a third trifilar transformer makes the circuit useful as a well-balanced mixer over the range of 2 to 30 MHz as shown in **Fig. 6.** Dynamic range is about 130 db with suitable diodes (hot carrier or very high speed switching types). Of course, a filter is needed after the mixer to remove the unwanted sideband. A voltage-controlled attenuator can be realized through the use of a variable dc voltage applied to the audio terminal. The *rf* signal to be controlled is fed into either of the other ports and is taken out from the port which is left. Signal input at the *rf* ports should not exceed a few hundred millivolts to avoid distortion. A little thought will reveal many other applications of this circuit.

I hope the information presented above will enable the homebrew artist to make his gear a little more up to date and at the same time get rid of that unpredictable carrier balance control.

. . . WA1FRJ

Reference:
1. Pappenfus, Bruene, and Schoenike, Single Sideband Principles And Circuits, McGraw-Hill, Inc., New York, 1964.
An excellent treatment is given in Chapter Five.

*Here we go again —
The FCC vs Sam Snell.*

An Adjustable High Voltage Supply

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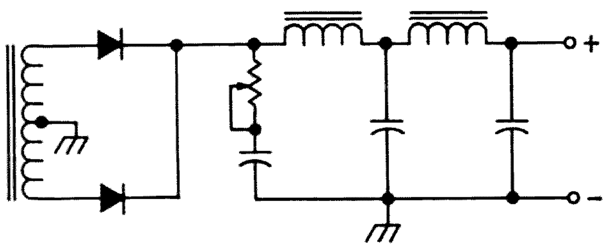

I am sure that every ham who ever built a power supply has had the sad experience of coming out with a voltage which was too high or too low for the project at hand. The usual practice is to try changing from a capacitor input filter to a choke input, or the reverse, in order to raise or lower the available voltage. Sometimes this works, that is if the voltage requirement is not too critical. Other times it doesn't, and we resort to expensive, power consuming, and poorly regulated voltage dividers.

As an example of a much more satisfactory method, let me relate my recent experience with a transceiver power supply. I had bridge rectified a TV transformer for high voltage and intended to take the low voltage off the center tap of the same transformer. The high voltage came out exactly right, the low voltage, which was to have been 250 volts under a 100 ma. load, came out at 230 volts with a choke input filter. An attempt at changing to a capacitor input failed miserably. 350 volts was much more than the rig could endure. It looked like time for the 20 watt resistors and all of that nonsense.

It would seem from the above that what was required was a filter which would operate somewhere between the choke and the capacitor input conditions, and this what I ended up with. In the diagram you will note a resistor in series with the positive lead of the input filter section. This resistance, when fully in the circuit, seriously limits the ability of the capacitor to charge and as a result the output voltage is reduced almost to the value of a choke input. On the other hand, when the resistor is reduced in value, the input filter charges to a more normal voltage and the output reflects this change. As may be seen from these two examples, it is possible to adjust the output voltage by merely adjusting the series resistor for the desired voltage at the required load.

It would be desirable to substitute a rheostat or adjustable resistor for setup purposes and replace it with a fixed resistor when the exact value is known.

I would suggest that values below 1000 Ohms would be most useful. In the example cited above a 500 Ohm, 10 watt resistor was used. Try it, it works like a charm.

"Henry is Spending the day in bed with a code."

Save Your Money!

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Don't throw away those audio and power transformers when they develop a defect. You might be able to repair them without much difficulty, or salvage them for other uses.

Most transformer troubles are shorted, or open, windings, shorts between separate windings, or shorts to the core. In a number of cases you will find some of these defects at the terminal points of the primary or secondary windings. It is best to remove the outer metal shell of the transformer and inspect the terminals for a broken wire or loose solder job. Should the terminal leads of the windings be of covered wire, it is best to check them as the heat from the equipment sometimes causes these leads to get brittle and break.

With center-tapped windings, an open will occur if the common connection is broken. Filament and high voltage windings are frequently center-tapped by bringing the two leads from the windings through a piece of spaghetti tubing and soldering the two leads together at the end. Sometimes this center-tapped lead may be cut too short when being assembled at the factory and may break the common lead and create an open. A repair can be made by stripping the insulation on the center tap lead and resoldering the two wires. This same proceedure should be used with tapped modulation or audio transformers.

A short to the core can usually be repaired without too much work. In numerous cases it is common practice to ground one side of the transformer as, for example, the filament plus winding. If a short should occur, all that is necessary is to reverse the leads of the filament windings. Should a short be found at some other point on the windings of the transformer, check it over visually, as the insulation may have worn off the wire and is grounding against something on the transformer. When the short is located, repairs can be made by using varnish or electrical tape. With internal shorts in the windings, it is best not to try to make repairs unless you are an experienced hand on re-winding jobs.

Now for some ideas to salvage those transformers in your junk box. A power transformer with an open high voltage secondary can be used as a filament transformer or a filter choke. When used for a filter choke, use only the primary leads and tape the secondary leads for safety. If the filament windings of the secondary are open, you can still use the transformer for the high voltage. With the primary winding open you can get surprising results by using the transformer for audio output. Connect the high-voltage secondary as the primary and the five or six volt filament winding as the secondary. Experiment with both sets of leads for best results.

Suppose you have a low power rig and need a cheap and easy way to modulate it. Dig that audio frequency output transformer with the open secondary winding out of your junk box and use it. Why not try Heising screen modulation? It may not be the best modulation but it will work well in any emergency. All you need is the primary of the transformer and a few inexpensive components and you are in business. Any ARRL Handbook will give you the circuits; transformer-coupled or clamp tube arrangements.

You can always use those small audio output transformers for small power supply chokes. All you do is cut off the secondary leads and use the primary. You will be surprised how many other applications these small transformers have if you try them in some of your pet projects.

Where transformers are beyond repair and can not be used for any of the ideas suggested in this article, salvage the wire from the coils. This will give you a good stock of wire to use for inductance coils. You can sell the iron core to the junk man.

Although this article refers to power and audio transformers, the same ideas can be used for salvaging interstage or modulation transformers. A word to the wise is sufficient; SAVE MONEY. . . . K6GKX

Transistor Oscillators

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Many pieces of amateur radio equipment —transmitters, receivers, test equipment and the like use oscillators in one form or another. These circuits generate ac voltages at fixed points across the entire communications spectrum. The signals generated by these devices are the heart of all communications systems.

In the beginning, amateurs used the spark gap as a rather crude method of generating *rf* energy. Frequencies were unimportant then and methods of detecting the energy sent by a transmitting station were also rather crude. The development of the vacuum tube made possible the generation and detection of signals with much improved quality and more precise control of frequequency. Through the years many tube oscillator circuits were developed with each having its own advantages with regard to stability and the frequency range to be covered. Indeed, even today a large percent age of amateur equipment in use still uses vacuum tubes.

During the last five or ten years, the transistor has begun to creep into amateur designs and a few commercial pieces of ham gear have become entirely solid state, except maybe for the last power producing stages of amplification. The semiconductor approach to communications equipment design offers a number of advantages over vacuum tubes in terms of power requirements and thermal considerations. This article describes and diagrams a number of solid state oscillator circuits which can be used to generate energy over a very wide frequency range. Each circuit, of course, has particular merits over a given band of frequencies.

Resonators

The dictionary defines the verb oscillate as "to swing to and fro like a pendulum." This definition is obviously directed at mechanical devices and might not seem to apply to electrical circuits. Not so. An electronic oscillator produces a signal which behaves in just such a way. The energy generated is in the form of an ac voltage which changes alternately between positive and negative potentials with respect to a zero reference level at a constant rate per unit time. This is the same as the motion of a clock pendulum swinging back and forth across a vertical line. The electrical analogy of this sort of mechanical system, of course, is the resonant or tuned circuit. It has a natural period of vibration so to speak in terms of the voltages and currents in its elements at a given time. A tuned circuit can be used in an oscillator to generate alternating current energy at its resonant frequency.

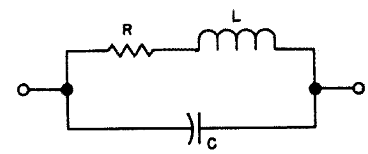


Fig. 1. *A parallel tuned circuit.*

To go back to the pendulum of a clock, it can be noted that the clock must be rewound periodically in order to keep it going. Because of the frictional losses in the various parts, the pendulum will not continue to swing forever once it is started. To keep the pendulum going over a long period of time it is necessary to give it a little kick with the spring mechanism in the clock each time it completes a swing. Electrical resonant circuits are exactly the same. A parallel resonant circuit is shown in **Fig. 1.** The inductance and capacity in the circuit produce the effect of making the circuit sensitive to oscillatory electrical vibrations at a particular frequency, and the resistance R is analogous to the frictional losses in the clock mechanism. Indeed if the resistance were zero (this is physically impossible) the circuit would oscillate and generate ac energy forever once it was pulsed with a signal at its natural resonant frequency. Maybe this is fortunate since if the resistance were not present, the tuned circuits that we devise would produce incessant oscillations excited by signals from broadcast stations, etc.

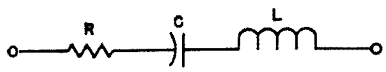
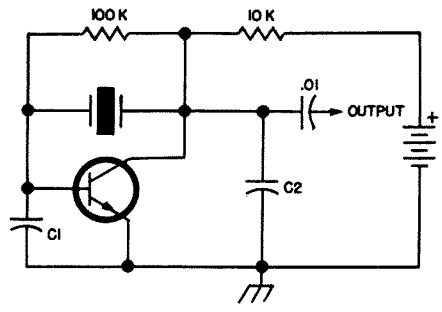


Fig. 2. A series resonant circuit.

Oscillators in general

An oscillator circuit adds the "kick to the pendulum". The active and passive elements of the circuit combine with the resonant circuit to keep it oscillating as long as power is supplied. Turning on the power produces enough noise (kick) to start the circuit oscillating. This brings up the matter of "Q" or quality factor of the tuned circuit. Q is defined as the ratio of the stored energy in an oscillating system to the energy lost per cycle of oscillation. In electrical circuits it can be thought of conveniently as the ratio of the ac reactance to the dc resistance in the circuit. Circuit losses make up part of this resistance and must also be taken into accounty. For example, placing a coil close to a ground shield may increase the coil loss, and thus the effective resistance, lowering the coil Q. The subject of Q is really quite involved, but it is only important to realize that it is necessary to furnish a little energy to a tuned circuit or oscillating system after each oscillation in order to compensate for the system losses to keep it in oscillation.

Almost any circuit with a resonant network will oscillate as many of us have discovered when trying to build devices which are intended for uses other than producing *rf* energy. This comes about because an oscillator is just an amplifier with the appropriate elements to produce oscillation. To provide the "kick" to the resonant circuit, it is only necessary to return a little bit of the energy from the output of the amplifier to the input in the proper phase relationship. Under this condition the amplifier will generate a signal at the natural resonant frequency of the network. In order to do this, of course, the gain of the amplifier must be greater than unity so that some power is left over to return to the input to keep the system going. The amount of power required to keep the oscillator excited depends upon the Q of the frequency determining circuit. The lower the Q, the more returning or feedback power required.



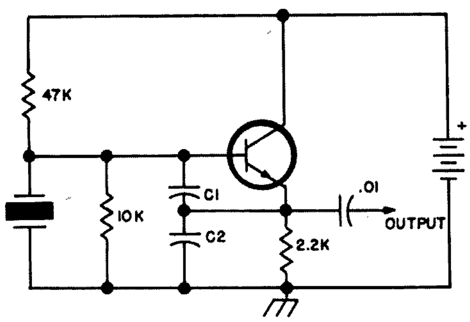
FREQUENCY RANGE	C1	C2
200 KHZ - 1 MHZ	1000 PF	470 PF
1 MHZ-5 MHZ	680 PF	390 PF
5 MHZ-30 MHZ	220 PF	180 PF

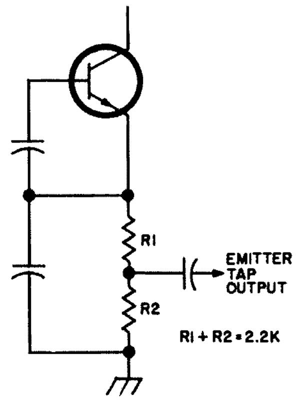
Fig. 3. Pierce oscillator circuit.

Crystal oscillator circuits

The resonant circuits for oscillators are usually made up of coils and capacitors. However, the piezoelectric quartz crystal is commonly used in amateur equipment, and this type resonator will be discussed first. A crystal is really the same as an LC network and such networks can replace it in almost all frequency determining circuits. The crystal has the very distinct advantage of having a very high Q and can be used to generate signals of much better stability than a coil-capacitor combination. Here it might be well to mention that most crystal oscillators use parallel resonant tuned circuit operation. This is the connection shown in **Fig. 1.** Some circuits make use of the series resonant condition shown in **Fig. 2.** Here the network presents only the circuit resistance at the resonant frequency while the parallel circuit of **Fig. 1** presents an extremely high resistance at resonance. A crystal not only acts like a tuned circuit; it can look like a parallel resonant circuit (**Fig. 1**) or a series resonant circuit (**Fig. 2**) depending upon how it is connected in the oscillator circuit. A complete discussion of why this is so is beyond the scope of this article, but information on crystals may be found in the literature. In the circuits to be described, the crystals are operating in a parallel or anti-resonant mode unless series operation is especially noted.

All of the circuits and values are designed around a good quality silicon npn transistor such as the 2N706. This device will work well in oscillators up into the vhf range. Other types are useable and type number is not too important as long as the





FREQUENCY RANGE	C1	C2
1-4 MHZ	820 PF	390 PF
4-10 MHZ	470 PF	220 PF
5-30 MHZ	220 PF	100 PF

Fig. 4. *Alternate* 1-30 *MHz oscillator.*

transistor is rated for the frequency to be generated. Supply voltage polarity is for the npn configuration and can be between 6 and 15 volts. Nine and 12 volts are good nominal battery values. For the circuits that require capacitor value changes with frequency, nominal values of capacitance are tabulated. Bias resistor values are nominal and some experimentation with R and C values may be needed for optimum results depending upon frequency and the circuit involved. In general the values indicated will produce good results.

Crystal oscillators for 200 kHz - 30 MHz

An old standby vacuum tube oscillator is the Pierce circuit with the crystal connected between plate and grid. A transistor version of this circuit is shown in **Fig. 3.** Here, as in the vacuum tube version, the crystal is connected in the same relative position, i.e. between collector and base on the transistor. It will be noted, however, that the semiconductor version of this circuit has some capacity added between the "hot" elements and ground. Transistors just don't have the intereleetrode capacitances that vacuum tubes do and their low impedance nature makes these capacitors necessary. They provide the feedback to make the transistor oscillate. Suffice it to say that this circuit will work from 200 kHz to 30 MHz.

Another circuit for about the same frequency range is diagrammed in **Fig. 4.** It will not work down as low as the Pierce, but will produce good results in the range from 1 to 30 MHz. This circuit is similar to the Clapp vfo circuit described later. The feedback capacitors in series from base to ground should be as shown to achieve a proper feedback ratio for the design frequency. This circuit is about the same as **Fig. 3** except that the transistor is operated in a grounded collector connection. Output can be taken from the emitter directly, or some isolation can be realized by splitting the emitter load into two resistors and taking the output from their common connection.

Crystal oscillators for frequencies above 30 MHz

At higher frequencies, crystal design dimensions become such that it is necessary to use quartz resonators in an overtone mode. Indeed crystals with fundamental frequencies up to 30 MHz or so are built, but their thickness dimensions reduces to only a few mils. Above 30 MHz it is easier to use a piece of quartz of more convenient dimensions and excite it on its 3rd, 5th, or 7th overtone (harmonic) in the oscillator in which it is used. The overtone frequency is not an exact multiple of the fundamental frequency of the crystal, but that is not important here. **Fig. 5** shows a circuit for use with overtone type crystals. It is a Hartley oscillator and the transistor is used in the grounded base configuration. The tank circuit in the collector should resonate at the overtone frequency of the crystal. The ratio of the capacitors across the tank coil determines the amount of feedback, and making the capacitor at the bottom end of the coil smaller will increase it. Here the output can be taken from either the collector or emitter of the transistor. This circuit makes use of the series resonant (short circuit) properties of the crystal to excite the amplifier. Here there is no phase reversal between emitter and collector and the crystal feeds back energy to the emitter in phase by virtue of its low impedance at the series resonant frequency.

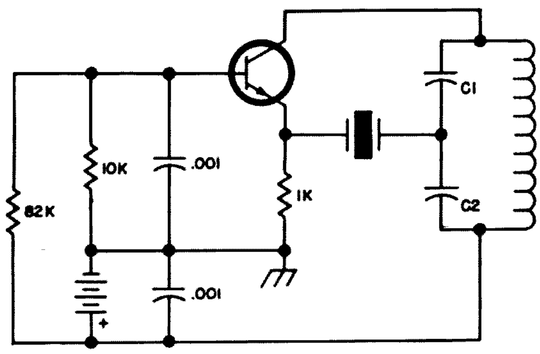


Fig. 5. *An overtone crystal oscillator.*

Low frequency crystal oscillators

Crystal controlled oscillators at 100 kHz are very useful for spot frequency checks in amateur receiving equipment. Transistors can be used at this frequency quite easily with the proper circuitry. The range from 20 to 200 kHz can be generated using the circuit of **Fig. 6.** A close look will show that this is the same circuit as **Fig. 2** except that an LC tank has been added to increase feedback to overcome the higher resistance of the lower frequency crystal. The tank circuit values can be computed from the formulas for the crystal frequency to be used. The coil can be an *rf* choke of about the right value and the tuning adjusted by CI.

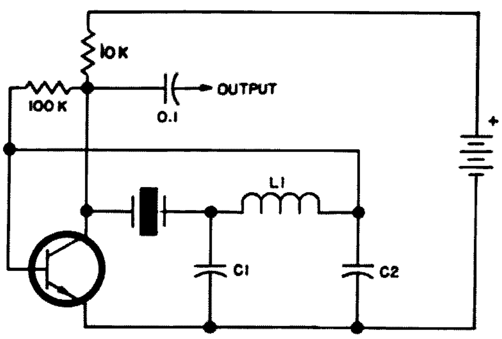


Fig. 6. *A low frequency crystal oscillator.*

An alternate circuit for low frequency use is shown in **Fig. 7.** It has the advantage of not using a coil and good results can be obtained with the values on the diagram from 20 to 200 kHz.

These crystal oscillators will give coverage from 20 kHz to 150 kHz with the proper crystal, adjustment and tuning. Before passing on to self controlled oscillators which can be moved about in frequency, it might be well to comment on the frequency accuracy of crystal oscillators. As has often been mentioned in the past, the marking on a crystal does not mean that its frequency is that plus or minus zero. Its oscillating frequency is determined primarily by its physical dimensions and finishing, but it is also affected by the oscillator circuit it is used in. All crystals are designed to work into a specific load capacitance (usually around 32 pF) for parallel or anti-resonant operation. To provide this load capacity it is important to put a small trimmer capacitor in series with the crystal in each of the anti-resonant circuits above if exact frequency

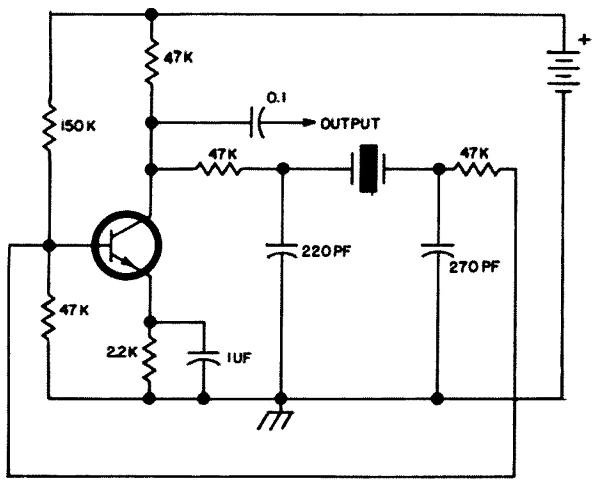


Fig. 7. *Alternate low frequency crystal oscillator.*

adjustment is necessary. In cases where a frequency error of a few kHz is not important, the trimmer can be omitted. For 100 kHz standards etc., it is a must.

Variable frequency oscillators

Crystal oscillators are extremely useful for generating precise spot frequencies, but the high Q of the crystal makes the adjustment range quite narrow. Where a wide band of frequencies is to be covered by a single oscillator a tuneable device is necessary. In the circuits just described, the crystal can be replaced with an LC resonant circuit which can be adjusted to the frequency desired. The stability of such an oscillator is not as good, but the ability to adjust the frequency over a wider range is quite useful. The variable circuits below are a bit different in schematic form, but their operation is identical to the crystal oscillators.

A circuit that is often used in amateur transmitters is the Clapp vfo. Its semiconductor version is shown in **Fig. 8** and, as noted, is similar to the crystal controlled

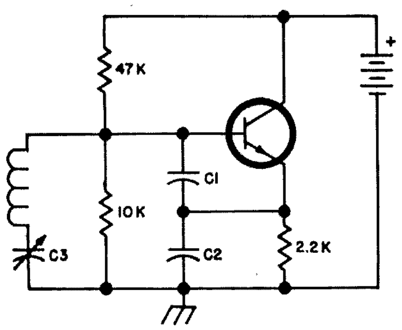


Fig. 8. *Clapp VFO oscillator.*

circuit of **Fig. 4.** The coil, and the series combination of capacitors across it, resonate at the operating frequency, and the large values at C1 and C2 provide for loose coupling to the tuned circuit producing good frequency stability for use in a vfo.

In the tuneable circuit, it is important to make C1 and C2 as large as possible while maintaining reliable oscillation to keep the coupling to the active circuit as small as possible. Typical values at 3.5 MHz might be 2000 pF at C1 and 820 pF at C2. For vfo use, experimentation here is in order. The tuning capacitor C3 is a normal type for vfo's and toroidal coils lend well to transistor construction projects. Output can be obtained as in **Fig. 4.**

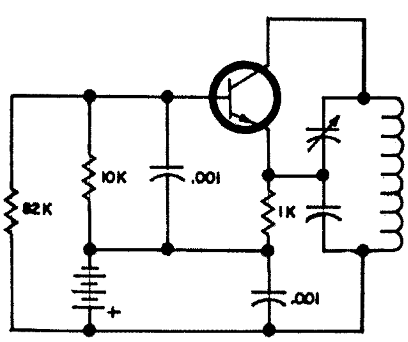


Fig. 9. *A general purpose oscillator for use up to VHF.*

The circuit just described will provide most of the rf frequencies for ham vfo use, but the circuit of **Fig. 9** can be used up to 200 MHz in test equipment, etc. It is of the same configuration as the crystal oscillator in **Fig. 5.** In the tuneable version of this circuit, the crystal is simply replaced by a short circuit and the tank circuit values in the collector control the frequency of oscillation. Without the crystal in the circuit the frequency stability is degraded, but this oscillator can be used up to vhf in a grid dip oscillator.

The circuit in Fig. 10 is shown as a matter of interest. It has no exact counterpart in the crystal oscillators described, but it will work well from 3.5 MHz on up into the vhf range. The transistor is connected grounded base and feedback is provided by the capacitor C1 from collector to emitter. C1 can be a small trimmer capacitor of about 30 pF maximum and used to adjust the feedback at the frequency range desired. L1 and C2 determine the frequency of oscillation.

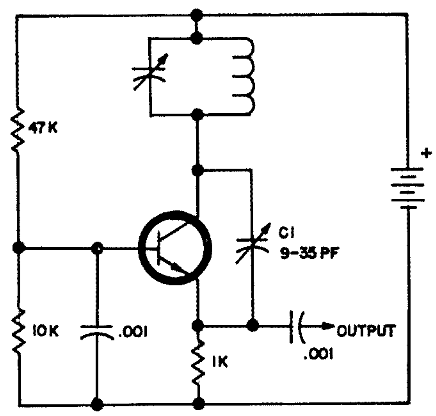


Fig. 10. *Another general purpose oscillator.*

Self controlled oscillators at the low and audio frequencies can be devised using tuned circuits, but their circuits are so many and varied that they are omitted here. At these frequencies oscillators commonly use RC time constant properties to produce the required signal; e.g. multivibrators, unijunction transistor oscillators, etc. The waveforms produced by these oscillators are more or less rectangular and they are intended for keyers and other timing circuits. The sinusoidal oscillators outlined in this article will give frequency coverage over the entire spectrum for amateur use and should be adequate for most purposes.

In closing it might be well to note again that the circuits and values shown are general. The usual ham method of "cut and try" may have to be used if the circuit doesn't oscillate at the first connection of power. Variations in crystals, tuned circuits and transistors are inevitable. The circuits and values shown provide a good starting point, and in most cases little adjustment will be necessary. . . . W9ZTK

Closed-circuit TV Camera

ATV RESEARCH announces the availability of its new line of SOLID-STATE MODULES for building your own TV camera (vidicon type) or for updating existing cameras. Through the use of these wired, pre-tested, encapsulated modules building a complete camera can be accomplished in a single evening. No previous TV knowledge or special test equipment is required.

Modules include: (1) Video module, (2) Vertical sweep module, (3) Horizontal sweep module, (4) RF modulated oscillator module and (5) DC-DC HV module.

Using the first four modules, experimenters and constructors can build a complete TV camera (less power supply). Power requirements include 12V for modules and focus coil, 6V for vidicon filament and 200 volts for the vidicon control circuitry through the use of the (5) module which amplifies and rectifies the horizontal sweep pulses.

These modules are compact, light weight and economically priced from $10 to $20 per module. Each module comes complete with hook up instructions.

Write ATV Research, Dakota City, NB, 68731.

Dear Kayla,

As an RTTY enthusiast, I was pleased to see several articles on the subject in the January issue. I feel I must comment on the WA8DCE article on page 42, however, as several statements are not only misleading, they are erroneous.

First ham radio pioneers did NOT develop "Frequency Shift Keying." We didn't even get on ham RTTY until after WW II, and "f.s.k." was in use soon after WW I by commercials.

The author mentions that 2975 is the "Mark" frequency, and that 2125 is the "Space" frequency. Not true, this is backwards, with mark always being the lower of the two, viz. 2125. The part that confuses most newcomers revolves around the use of lower sideband for receiving. The transmitted "r.f." is actually lowered for space, which then changes the tone in the speaker higher for audio. This is confusing, and most unfortunate, but that's the way it got started and remains to this day. You can listen on upper sideband, of course, but then the tones come out backwards in the speaker from normal. "H.F." and "V.H.F." techniques are identical, and the use of lower sideband for receiving on h.f. then gives the proper relationship of mark and space tones in the speaker (and also the RTTY demodulator).

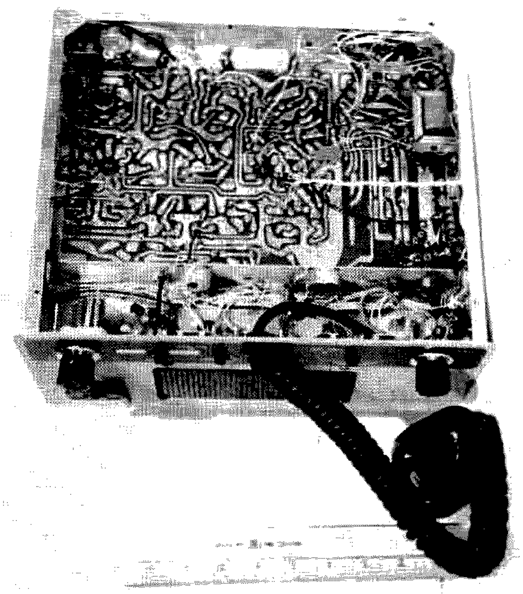
When he spoke of the tones generated by the "a.f.s.k." unit into the mike input, he was correct–again, "lower sideband" position on the transmitter is used if it is a "s.s.b." type with suppressed carrier.

I hope this clarifies the situation, which is confusing enough even when understood perfectly.

Irv Hoff, W6FFC

Ralph Hanna W8QUR
3023 Emmick
Toledo, Ohio 43606

Heathkit HW18-3 160 Meter SSB Transceiver



Toledo has always been a town that was active on 160 meters. This goes back to the very early days when mobile operation was not permitted except on 5 meters. W8HSW and several others got together during this time and put a 160 meter rig in an automobile. The whole amateur fraternity of Toledo was really shook when they proceeded to come on the air one Saturday morning and moved all over town operating as a portable. Someone got so upset they called the FCC in Detroit to complain only to find out that W8HSW had written the FCC as required and advised that they would be operating portable from about 20 different street intersections.

As soon as the 160 meter band was opened for mobile operation, Toledo was quick to do something about it. It was easy to get the car BC receiver to tune to 1800 and not lose too much of the broadcast band. A simple two or three tube transmitter crystal controlled was easy to build. The end result was that Toledo had an awful lot of mobiles on 1812 kHz plus at least 5 boat mobile to say nothing of the home rigs that could operate on 160.

With this interest on 160 it was only natural that I should be interested when Heath Company announced they were going to put out a 160 meter Single Side Band transceiver. Very few of the SSB exciters covered 160. Down converters to go from 40 meters to 160 seemed such a waste of power.

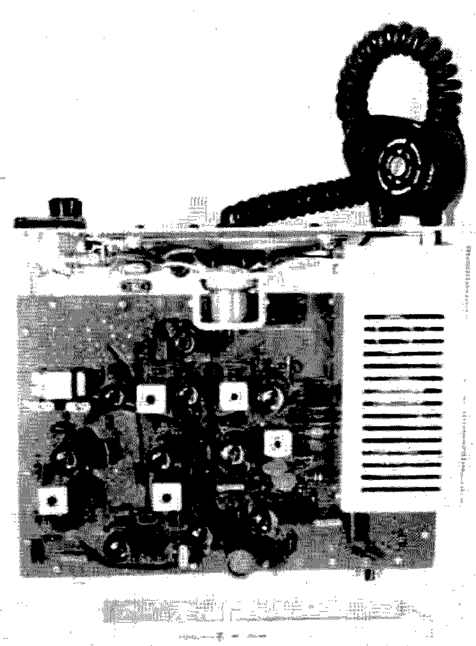
The kit was a little longer coming than I had planned and arrived a couple of days before we were to leave on four weeks vacation on our boat. I took the kit along so I could work on it on a rainy day and in the evening when all was quiet. I can now have great sympathy for those fellows who put a kit together in an apartment. I am used to a large work bench in the basement so this was a new experience for me. Pick up all the parts and put them away when Virginia had lunch ready, put them all away when we got ready for bed and be sure to store them real good so they would not upset in rough seas on the next day's run. Anyhow it went together in the usual fun way that all Heathkits have a habit of doing.

Sometime along the way the FCC changed the portions of the band that could be used

in various areas and also changed the input power limits in many cases by a considerable amount. As a result of this, interest in 160 has increased. I'll bet there are people on 160 that haven't been on since before World War II.

I was glad that I had the HW18-3 because I was in there with the rest of them with no trouble at all. The SSB or AM feature was sure good too. The two crystal control frequencies were OK but too often the other station would not be transmitting on same frequency as he was receiving. When it was explained that you were crystal controlled, it was no problem to get him to zero beat your frequency. The clarifier could then take care of any slight drift. It was surprising though how many of the fellows were crystal control, especially the mobiles.

It didn't take me long to find out that a VFO would make operation real fun. It also took even less time to find out the LMO in the SB100 tuned the exact range of frequencies needed for the VFO in the HW18-3. A simple coax cable with a crystal socket on one end and an RCA plug on the other and I was in business with a real fine VFO. The only drawback here was that the dial runs backward but you can easily get used to this. Any VFO that tunes 5.2 MHz to 5.4 MHz will work very nice. The instruction book tells all that is required for a VFO and anyone who wants to go this route should have no trouble.



Operating was real fun and contacts were made like back when I first got my ticket many years ago. Actually with sideband it didn't seem so crowded. Maybe this was due to the sharp crystal filter in the HW18-3. Enough of the operation of the rig, so now on to the technical.

Enough has been said in the past on the ease of construction of a Heathkit that I won't to into it here. No trouble was encountered in tuning and adjusting. The only trouble was that the HW18-3 takes 250 volts on the low side and both my power supplies were wired for the 300 volts. Since I wanted to use the same supplies for both rigs a switch was installed in both the ac and the dc supplies. By the way, a newer HP23A supply has the switch already installed.

One point that sticks out is that there is no relay used to go from receive to transmit. It's like magic, no relay clatter, the receiver goes dead and as soon as you talk into the microphone the meter swings. This is accomplished with several diodes. The first of which is a clever T-R switch in the antenna circuit where the diode is back biased to cut off so no rf can get to the receiver in the transmit position, but in receive the diode is like a short circuit. I checked with a calibrated signal and found no difference with the diode shorted out or with it in the circuit. While transmitting, the unused portion of the receiver is also biased quite high so that it is completely cut off. A T-R amplifier tube is controlled by the PTT switch on the microphone and this places the high positive bias on the T-R diode. This same portion of the PTT switch also control the negative bias on the receiver tubes, which are cut off when transmitting.

Except for the control system mentioned above, the circuitry is pretty much a standard dual conversion filter type transceiver. The *if* is the usual Heath 3395 kHz. A four crystal lattice filter gives good selectivity of about 2.1 kHz.

The transmitter ends up in a pair of 6GE5 beam power tubes. "Sylvania News" tell us that these tubes can be run in SSB service 1.25 times their regular rating which would be about 175 watts for one of them. Since Heath only runs them at 100 watts (200 PEP) they are not working too hard.

Provision is made to run in the AM mode by a front panel switch. In the AM position a minimum of 40 watts is run in the final and this is single sideband with carrier so that it appears much stronger than 40 watts of straight AM. The ALC action is a bit stronger here than on SSB.

As mentioned above, ALC is incorporated. This is accomplished by picking off any positive audio swing of the grids of the final caused by too much grid drive. The audio is rectified and filtered and used to control the transmitter *if*, mixer and driver tubes. The same circuit was high negative bias applied in the receive position which effectively cuts off the transmitter.

The tune up and alignment was so simple you wouldn't believe it. Adjust the slugs in the *if* coils for highest S meter reading and that is it for the receiver. The transmitter was just as easy. Set the bias, adjust a couple of slugs, then adjust the carrier null.

There is no final adjustment for the transmitter as this is all pretuned to match a 50 ohm antenna.

Checking the output on SSB showed that with a single tone signal, the unwanted sideband was down 47 db and the carrier was 46 db down after the balanced modulator was touched up just a bit. The output was just a bit over 105 watts PEP. On AM with no modulation the output was 20 watts and the modulation increased it. Good on the air reports were received from everyone when using either mode and, of course, the SSB signal was much more potent.

The receiver performance is really something, I thought that the all band receiver I have been using was good but this one is better. You would be surprised at how much the noise is reduced with the sharp 2.1 kHz filter. I didn't think it possible that the 4 crystal filter would be this sharp but I couldn't prove any different. The sensitivity was better than the 0.5 microvolts that Heath claimed by about .01 microvolts.

With the new FCC changes for 160 meters there should be a lot of activity this year. Here is quick easy way to get there and much better than a transverter. My antenna leaves a lot to be desired so I'm going to have to do something about that, maybe a vertical on top of the tower.

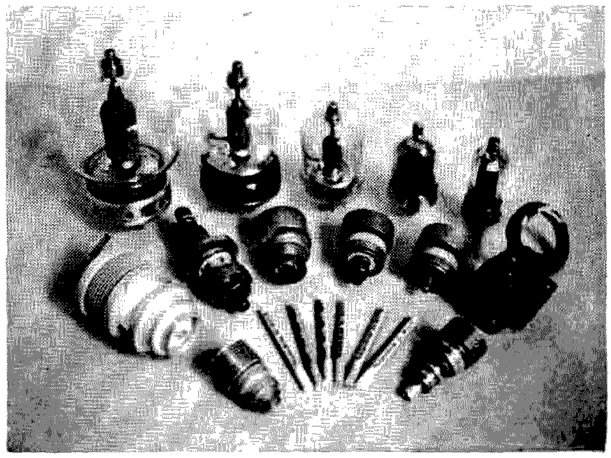
. . . W8QUR

COOL IT!

David Oliva—K9CNN
818 *Valley View Dr.*
Glen Ellyn, Ill. 60137

When constructing any piece of electronic gear that requires cooling, the average ham often does not have available to him the equipment or information to do a first class job. Even with the proper blowers available, if improper techniques are used, inadequate cooling may result in tube and circuit damage. Math as applied to air flow is fine but unfortuantely few hams have the patience or associated equipment to use it. The following article was written with the hope that it will put and keep more hams on the air with their favorite VHF rigs.

At hamfests, auctions and surplus stores be on the lookout for blowers of various types. Do not be afraid to use large size blowers if mounting is practical. Squirrel cage blowers are to be preferred over dc high rpm surplus types. The high rpm blowers do not last very long in continuous service and also produce a terrific racket. This is the price paid for small size. Higher RPM cage types are to be preferred over lower rpm blowers for cooling VHF tubes with special air system sockets such as the 4X250 series.



Some VHF tubes requiring forced air cooling. Top left to right; 5D22-4-250, 4-125, 4-65, 6146, 2E26, *can be cooled by low velocity type blowers.*

Middle row; 6283, 6383 *(water cooled)*, 8119, 4CX250K, 4CX250, BL800 *klystron (may be conduction cooled also).*

Bottom row; 6884, *Thermochrom temperature indicator crayons*, and* 2C39. *These tubes are best cooled by medium to heavy duty high speed blowers of the squirrel cage type and may take up to* 1/6 *HP motors with speeds from* 1800 *to* 3600 *RPM.*

A 1296 *MC tripler using a favorite cooling method here. No back pressure is produced by blowing the air across the cooling fins of the* 2C39. *Running in tripler service with* 800 *volts on the plate and in excess of* 10 *watts RF out, the tube and blower are both cool! This would not be possible with this small blower in an enclosed cavity construction. The blower is mounted on rubber grommets to avoid "blower modulation" of the tube. This may happen with high frequency tubes because of the close element spacing required.*

Flexible tubing and clamps of all types can be useful in making connections from the blower to the area to be cooled. A central air box with several outlets of smaller tubing can be used to cool several small tubes. This eliminates the necessity of making a pressurized chassis which is sometimes inconvenient.

Small holes in sheet metal boxes can be very conveniently plugged with epoxy cement which will stick to almost anything. Be careful not to put epoxy on any screws you might later want to remove as this could prove a calamity!

A good "poor man's" blower can be made from a phonograph motor, using a small fan blade mounted in a tin can with the ends removed. Brackets can be used to mount the can near the tube to be cooled. Rubber grommets should be used to mount the motor to minimize the vibration. This arrangement makes a neat little wind tunnel that is easy to handle for small cooling jobs.

Screening over open areas for rf tight enclosures must be chosen with care. Small mesh screening is to be avoided as it will slow the air flow. Pre-punched aluminum screen is to be preferred, or even make your own covers with 3/16 to 1/4 inch holes for the air to escape. Remember that the larger the area to be cooled the more air flow you need. The more obstructions to the flow such as sockets, chimneys and tubes, the more high speed air you will need to do the job.

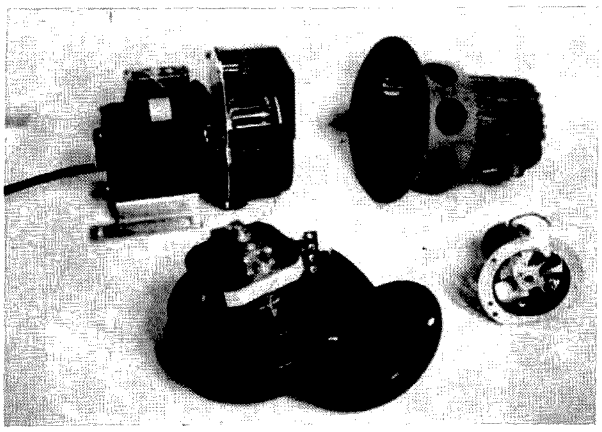
Your blower may speed up after installation is complete and all plates are in place for an air tight compartment. This is an indication of too much back pressure and will cause blower overheating. A larger blower is in order or this condition may be relieved by partially blocking the air *intake.* This will slow down the blower to its normal speed but will decrease the cooling efficiency of the system. The best solution for a situation like this is a blower that will handle higher back pressures, and this is not necessarily cured by the size of the blower.

Rules for cooling—

1. Don't add on the blower as an afterthought. This will complicate construction of a rig enormously and the blower selected sometimes will not fit at all!
2. Get the blower as close to the tube as possible for best cooling.
3. Use a small enclosure in preference to a big one; make an enclosed box for the tube to be cooled with input ***and output*** holes.
4. Avoid, at all costs, right angle bends or corners unless the blower picked for the job is more than adequate. A straight shot from blower to tube to vent is the best way to cool.
5. Take advantage of "convection construction" whenever possible; let the heat rise and not be trapped in enclosed spaces.
6. Bypass blower leads for minimum "hash" interference; use brushless type motors whenever possible.
7. The quieter the blower the better. Other hams do not relish hearing loud blower sounds modulating the carrier with vibration and mike pick-up.
8. Be sure to allow adequate screened opening for the air exhaust, to avoid building up unnecessary back pressure.
9. Use temperature indicators if in doubt of final tube temperature. Observe all safety precautions while measuring temperatures when final is operating.

Proper air cooling for your final will pay off in fewer breakdowns and more hours of carefree QSOs. Now—pick up your best blower and start building that favorite VHF rig.

. . . K9CNN



Top left to right, squirrel cage brute 1/6 HP, squirrel cage puller type (draws air into cage).

Bottom row, squirrel cage with "phono" motor (very limited cooling capability), and last the DC motor surplus special. This operates at 28 V DC, 1 amp. and 15,000 RPM. At half speed the noise is terriffic! Motor life due to brush wear is also poor. This type of blower produces much electrical interference and also requires a separate DC supply to operate it.

*Temperature indicating crayons are available from Thermochrom, Curtiss Wright, Princeton Division, Princeton, New Jersey. When the temperature of the crayon rubbed on the tube surface is exceeded the color changes. In no case should the tube temperature exceed the manufacturers rating, and any temperature above 250°C means trouble.

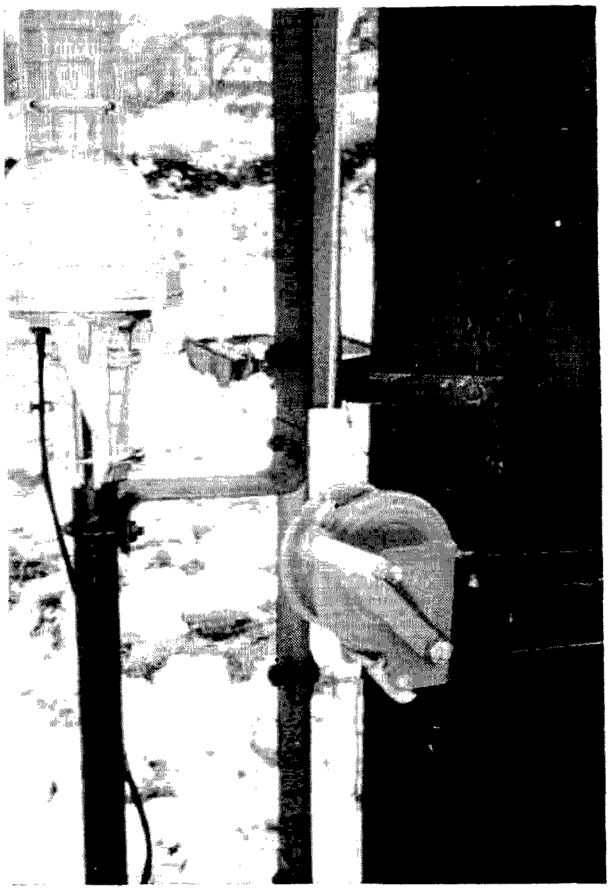
Dear Wayne,

How much tongue in cheek is involved in your de W2NSD/1 in January I don't know, but I like it anyway. The second paragraph on page 4 is a real honey. Please note that several channels on 20 meters have been occupied as you suggest for a long time. 14,336 is the Independent County Hunters Net. We are on 7 days a week, almost all day. We have a common interest and we really get along as good friends. On 14,332 is the International Single Sideband Net. They have a great comradship and even put out a lovely little magazine once or twice a year. Of course 14,340 is the CHC Net with ole K6 Bad Xample. When 50 or so hams, all interested in the same thing, gather on one channel together it leaves lots more room for individual QSO's.

Bertha, WA4BMC

A New Support for That Beam

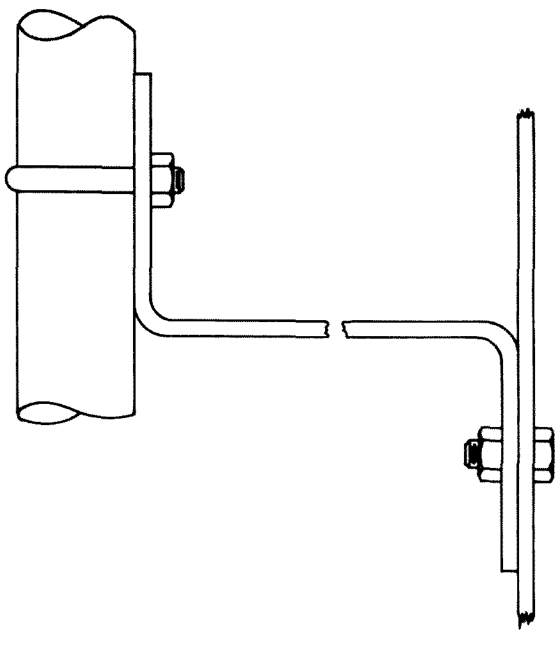
Peter D. Black K1MYV
Gage Hill Rd.
Pelham, New Hampshire 03076

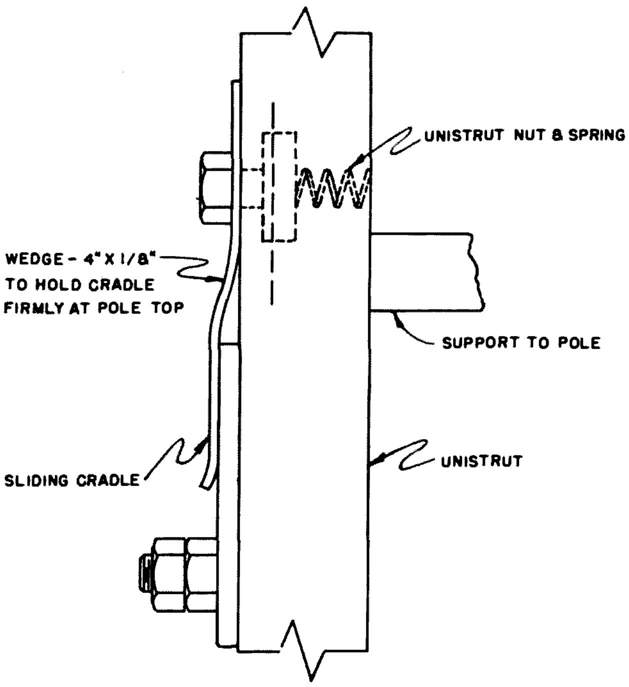


There is almost always more than one way to skin a cat, or even to support a beam, so here is what I believe to be a slightly different approach. Having reached the age of reason or cowardice, whichever you prefer to call it, my ideas were concentrated on bringing the beam down to me for adjustments or repairs rather than climbing up to it. Also being oriented, by reason of employment, to supporting wires on poles, my thoughts naturally turned to that method, so how to run a beam up and down a pole was the problem.

From somewhere I remembered that a product called Uni-strut looked a good deal like a track and was quite strong. Here's the result which has been through two full years with the beam in place, and has been raised and lowered many times with the greatest of ease. All the fabrication was done at a workbench in my cellar with only a portable electric drill (⅜") and the typical assortment of hand tools.

The attached picture and sketches are almost self-explanatory. The pole is a 45 foot, class 5, treated hard pine, which was obtained from a pole treating plant about ten miles away and delivered to the site by the supplier. I was permitted to pick out a nice straight one from the yard. The attachment of track, winch, etc. was done in my yard very close to the appointed place of setting. The track is standard Uni-Strut channel (1⅝ inches square) which came in 8 foot lengths. The brackets which attach the track to the pole are ¼ inch x 1¼ inch flat iron, bent to shape with a vise, and fastened to the pole with ⅜" x 2" lag screws. Sections of the track are fastened together with the same ¼ inch x 1¼ inch flat iron. The cradle which supports the rotator and slides up and down the track is ⅛ inch x 4 inch flat iron, again bent cold at the vise in the cellar. Bending of both the brackets and cradle pieces was accomplished quite easily by clamping the piece





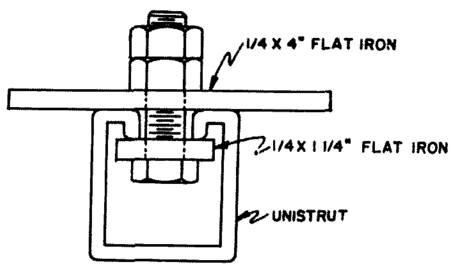
in the vise and attaching a three foot piece of two by four to the protruding piece to be bent, using "C" clamps. The bends produced are square and sharp enough. Near the top of the track, a piece of the same 1/8" x 4"iron is attached to the face of the track and bent as shown to provide a slot into which the cradle is pulled up, thus holding the cradle tightly against the track at the top. This seemed necessary because the three bolts which hold the cradle to the track must be a little loose to permit the cradle to slide on the track. There should be one of the track brackets to the pole near this slot.

Above the top of the track, I mounted a pulley wheel of fair size (four to six inches diameter) attached to the sides of this track with the aforementioned 1/4" x 1 1/4" iron. I bent this in a loop over the pulley, close enough so that the steel cable over the pulley could not get out of the groove of the wheel. The winch, again mounted on 1/4" x 1 1/4" iron, fastened to the pole with lags, is a small boat winch, designed for 1600 lbs. pull, and picked out of the catalog of a famous mail order house. The cable is fine strand flexible steel rated at 700 lbs. breaking strength. The combined weight of cradle, rotator, and three element beam to be lifted is less than 100 lbs.

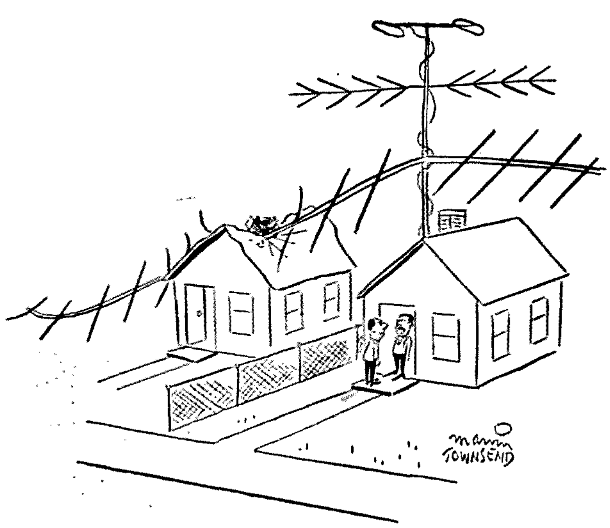
The pole was set about six feet in the ground after complete assembly but with the cradle and beam temporarily removed. The cable was in place over the pulley at the top. Lacking complete confidence in my own work, I did step the pole for climbing but have not had to go up yet. The steps are at 90° instead of 180°, as is customary, to permit the beam to clear coming down. In my case the control cable and feed line are supported at about 20 feet above ground on the trunk of a tree about 25 feet away from the pole, and a slightly slack loop maintained to the cradle when at the top. This permits the cradle to be dropped without disconnection of these feeds. It can be lowered only in one position where all beam elements clear the pole and steps in coming down.

Work out your own details of construction, gentlemen, and I'm sure you can improve on mine. Oh, I forgot to mention—you'll find it real cheap, if you don't count your hours of work in fabricating and assembly.

BOTTOM NUT LEFT LOOSE ENOUGH TO
PERMIT CRADLE TO SLIDE ON UNISTRUT.



. . . K1MYV



"What's the beef this time? Interfering with your TV reception again!"

The Case for the 1/2 Wavelength Feedline

R. T. Hart W5QJR
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516 Belt Line Rd.
Richardson, Texas 75080

The antenna, one of the most important elements in a communications system, is often the least understood portion of the radio amateur's station. It has been demonstrated that many antennas, when correctly tuned, produce an increased efficiency of 10 dB or more in receive and transmit signal strength, compared to the amateur's normal tuning method of using a VSWR Bridge. These facts have become apparent in the number of inquiries and comments received by the author in the use of the Antenna Noise Bridge (73, October, 1967). The purpose of this article is to briefly describe the essential features of an antenna system and their optimization for maximum performance.

An antenna is basically a resonant circuit. For maximum performance it must be tuned to resonance for the same reason that the transmitter output circuit must be tuned to resonance. When the transmitter frequency is changed, it is standard practice to "dip the final", and the antenna resonant frequency should also be changed if maximum performance is desired.

The antenna is basically a series resonant circuit with a resistive component, as shown in **Fig. 1.** The resistive component is referred to as the radiation resistance. Maximum current flow will occur in the resistance only at the resonant frequency. The value of the resistive component is a function of antenna height, ratio of physical to electrical length (loaded antennas) and other factors. The resonant frequency is a function of the physical characteristics of the antenna and proximity to other objects. The major problem, when looking at the overall system, is that the antenna must be physically separated from the transmitter, hence the need for a feedline. This article is concerned with coax feedline. If an antenna tuner is used, this line is short and the antenna is virtually moved into the shack. The normal procedure for amateur antennas is to use a coax line length just long enough to go from the transmitter to the antenna, and herein lies the problem. If a random length of feedline is used and the antenna does not have the same radiation resistance as the coax characteristic impedance (nominally 50 ohms), the power doesn't get to the antenna due to losses in the mismatch and to radiation from the coax. For this case, the coax becomes part of the antenna system. On the other hand, if a half wavelength of coax (or multiple) is used, the effect of the coax may be disregarded. The coax itself is the equivalent of a series resonant circuit. When the coax and the antenna are connected, if the line length is proper, the antenna feedpoint is virtually moved to the transmitter end of the coax.

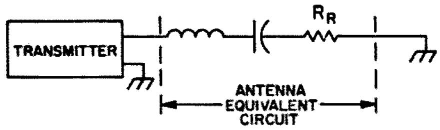


Fig. 1. Series resonant circuit.

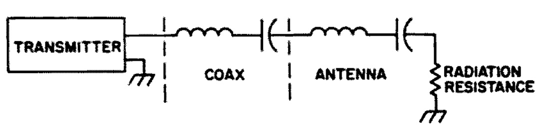


Fig. 2. Simplified antenna system.

With reference to **Fig. 2,** note that the entire antenna system can be simplified to the resonant circuit of the coax and the resonant circuit of the antenna, with the radiation resistance (feedpoint impedance) as the desired "load" for the transmitter. If the coax is a half wavelength long (or multiple), it effectively will be series resonant and thus a short circuit. If the antenna is also resonant at the same frequency, maximum current will flow in the radiation

resistance and hence maximum antenna efficiency.

If the coax is not a half wavelength, changing the length of the antenna can cause the entire circuit to be resonant, but the effect is to cause the coax to be part of the resonant circuit and hence radiation from the coax occurs. In addition, the antenna itself will not be a resonant circuit; hence, the resultant high impedance of the tuned circuit will prevent maximum current flow in the radiation resistance. This is not true if the antenna radiation resistance is the same as the characteristic impedance of the coax. Another effect is that the value of radiation resistance measured at the transmit end of the coax is not the same as the value at the antenna if the coax is other than ½ wavelength and the radiation resistance is other than 50 ohms.

The problem is aggravated by the fact that the antenna is resistive only at the true resonant frequency of the antenna. A few kHz from the antenna resonant frequency, the value of capacitive or inductive reactance reaches a high value for the antenna itself. Hence, the coax is no longer properly terminated, even if it were 50 ohms at the resonant frequency. The effective bandwidth of the antenna will be greatest if a matching network is used.

Most amateur antennas, particularly 80 or 40 meter dipoles and mobile antennas, have a low value of radiation resistance. These antennas will have low efficiencies unless a matching network is used to overcome losses in the antenna conductor. (See the ARRL Antenna Handbook.) Most beams use a matching network and are extremely difficult to adjust properly using a VSWR Bridge. The WSWR Bridge has the basic limitation that it cannot differentiate between resistive and reactive components. Most amateurs, not realizing this limitation, operate their antenna at the frequency of lowest VSWR, *which is not necessarily the same as the most efficient frequency.*

If a system is tuned using the following steps, maximum efficiency will occur:

(1) Use half wavelength coax, or multiple thereof, or locate the Bridge at the antenna feedpoint.

(2) Tune the antenna to the desired frequency.

(3) Adjust the matching network for 50 ohms.

If this procedure is used, minimum VSWR will occur at the frequency of optimum efficiency. If the coax is other than ½ wavelength (during tune up), the antenna is not properly tuned, or if the radiation resistance is not the same value as the characteristic impedance of the coax, minimum VSWR will not occur at the frequency of highest efficiency.

If the system is operating properly, changing the length of coax will not affect the VSWR reading. (Use ¼ wavelength coax for worse case measurement.) Thus, when adjusting an antenna using a VSWR Bridge, if the coax line length is alternately changed between measurements, eventually a proper combination can be reached. This is a tedious process and does not give an indication as to what to do to adjust the system. For this reason, an *rf* bridge is required to measure independently the resonant frequency and radiation resistance to allow tuning the antenna to the desired frequency first then to allow adjusting the matching network. Many *rf* bridges are available for this purpose, including the Heath Kit Antenna Scope, the Millen Bridge, General Radio Bridges, and the Omega-t Antenna Noise Bridge.

A mobile antenna, particularly on 40 or 80 meters, must utilize a matching network. The nominal radiation resistance is typically very low and when the system is operated at the frequency of minimum VSWR without a matching network, the resonant frequency will be out of band and the antenna will not give maximum efficiency.

The same comments hold for beam antennas. Here again, minimum VSWR does not necessarily mean that the antenna is resonant and the matching network is adjusted properly. Also, if a coax line of other than ½ wavelength is used, the entire system may be "down in performance" by many db.

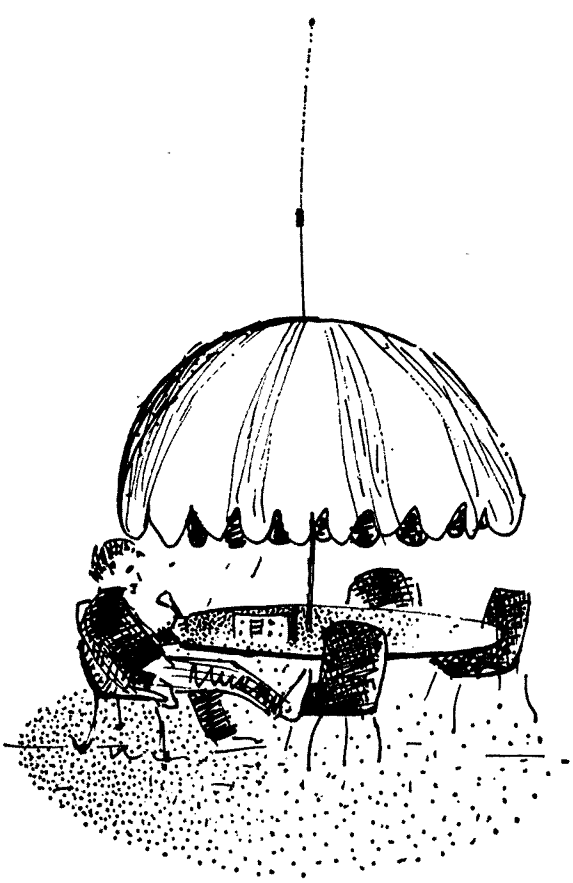
When using a multiband antenna, the coax length should be chosen for a multiple of ½ wavelength for all bands. Example: For a 10-15-20 triband beam a ½ wavelength coax on 40 meters (approximately 44 ft. RG-8U) gives 1 wavelength on 20, 1½ wavelength on 15, and 2 wavelengths on 10. If this is too short, the next length would be 1 wavelength on 40 (approximately 88 ft. of RG-8U) which gives 2 λ on 20, 3 λ on 15, 4λ on 10 meters. If this is too long,

it is better to coil up the excess in the corner rather than cut it off and not have the proper electrical length of feedline.

To achieve maximum antenna performance these considerations should be applied to all amateur antennas in addition to the normal choice of antenna type, height above ground, etc. These considerations do not rule out the case of using ¼ λ lines for matching networks.

As an example of the relatively critical tuning of antennas, the antenna conductor forms the inductive component of the tuned circuit. The capacitive component uses air as the dielectric, and the capacitive component is distributed along the conductor. If the dielectric constant changes, the resonant frequency of the antenna will change. Among other factors, the relative humidity of the air is influential. A 40 meter dipole has been observed and changes of 200 kHz in the resonant frequency are not uncommon from dry air to measurements made while rain is falling.

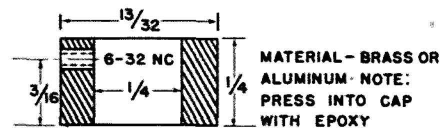
Before you purchase the linear, tune up the antenna. It's cheaper and the results will be about the same. Then, if you add the linear, the rest of the crowd will move over when you come in. . . . W5QJR



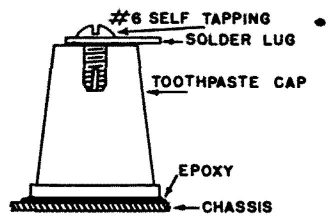
Putting Creativity to Work

D. E. Hausman VE3BUE
54 Walter Street,
Kitchener, Ontario, Can.

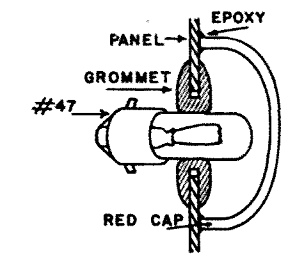
The purpose of this article is to show how the radio amateur can use his creativity for his benefit. As an example of what I mean by creativity, I shall describe several ways of using such common items as toothpaste tube caps and the like. In all cases it will be readily apparent that the cost ofconverting these inexpensive caps into useful and needed items is small, the conversion is easy and the new item is in some cases difficult and expensive to get commercially.



FERRULE FOR KNOBS



STANDOFF INSULATOR



DELUXE WARNING LIGHT

Stand-off insulators

Small caps, especially those from toothpaste tubes, can make dandy stand-off insulators. The diagram shows how a solder lug is held by a #6 self-tapping screw. More than one lug can be used if necessary. The completed insulator is attached by means of epoxy glue or similar adhesive. The use of these insulators is not recommended in high-voltage circuits for obvious reasons.

Deluxe warning light

Do you want your "warning" lights to command the attention they deserve? The cap from a detergent bottle, etc. will make a large dome that, when illuminated even by a #47 bulb, will command far greater attention than those small "jewels". It is perfect for the B+ pilot light in a linear amplifier or high power transmitter. A red cap will, of course, be best for this application. The diagram shows how the pilot lamp is held by a grommet and how the cap is cemented over the lamp with epoxy glue. A commercially available lamp socket can be used, however, at a greater expense.

Protective feet

And when you finish that new construction project, you will need some protective feet to protect your operating bench from mars or scratches. A common toothpaste tube cap comes to the rescue with no modifications. Simply glue these caps to the bottom of your project, and there you are. These caps are surprisingly strong and will support quite a heavy load.

Miniature knobs

Since the introduction of solid state devices, the size of electronic equipment has become smaller and smaller. If standard size knobs are used on such gear, there will be no room in-between the knobs for the fingers. Again, toothpaste tube caps can be converted into small knobs. The diagram shows how a brass or aluminum ferrule is made to fit inside the knob. Epoxy glue holds this ferrule securely. A hole is then drilled in the side of the cap and a tap is used to thread the hole. A 6/32 tap is a good size. The dimensions given in the drawing are "universal" and will work with nearly all toothpaste tube caps. The easiest way to make the ferrule is to use a lathe. If this is not possible, get some 3/8-inch brass from an industrial supplies dealer (look in the yellow pages) and after cutting the stock into 1/4 inch lengths, drill a 1/4 inch hole concentric to the circumference of the brass. In some cases, miniature controls come in 1/8 inch shafts and

suitably sized knobs are difficult to get. If you use homebrew knobs it will be no problem making this smaller hole. The set-screw is a 6-32 x ½ inch screw with the head cut off and a slot cut in the end with a hack saw. If you need an index line, take a toothpick and after dipping it in a bottle of India ink, darken one of the ribs along the side of the cap.

Although this may be redundant; get your wife to save up all the caps she gets. So there you have it; it's not that hard to use your head and come up with some mighty useful items.

. . .VE3BUE

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters have been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

CLUB SECRETARIES NOTE

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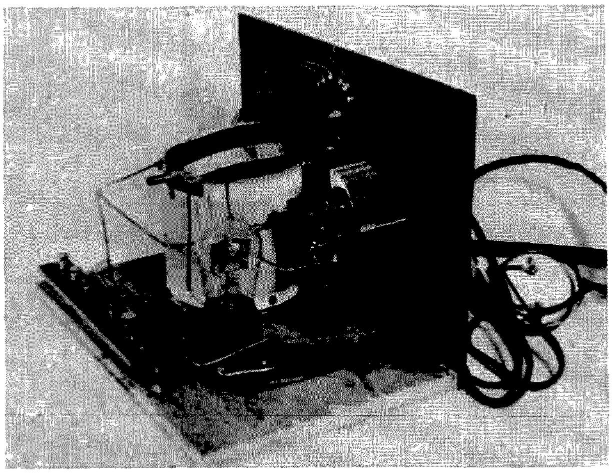
The Lamb Dyer

Ted Woolner WA1ABP
30 Cedar Rd.
Shrewsbury, Mass.



It's hard to start a story that many will not believe, but, I'll have you know, that better than half the lies I tell are true. This all started when I was studying to become a ham in 1963 . . . The teacher allowed as how it would be impossible for me to remember how to make a receiver such as I had made in 1921 when I was a "Child radio nut." We were all called "Radio Nuts" in them there days and we all made our own receivers and invented enormous lies about stations we had heard the night before. The red ears were not a sign of shame about these lies, but merely head-phone-itis. We loved our radios and here was a teacher that had the unmittigated gall to say I couldn't do it now!

It took a lot of time and a lot of attic searching but finally 1 had all the parts—including the U V 200 Radiotron detector tube! The work started. Being older and having a better supply of tools than a twelve year old country boy, it went along fast and the finished product, a one tube regenerative, using a vario-coupler tuned with both "Taps" and a variable condenser across it. One end of a tickler coil to the plate of the tube and the other end to the headphones created the necessary feed-back or "regeneration."—I was, again, a care-free boy of thirteen! That is the way I felt! Now, hook up the storage battery and the "B" battery, place the headphones (Brande's) on the head and slowly, with bated breath turn the rheostat on. Aaaaaah, the old tube lights up a little, turn it up a bit further—it glows brightly and the old familiar rushing sound comes out of the ancient ear-phones . . . By golly, it's gonna work! Flatten out the tickler, move the tuning dial and there is the old familiar whistle. Now, tip the tickler just to the breaking point of oscillation. There it is, a dance orchestra playing a number from out of the past—Lime House Blues! Gosh, it had been many years since I had heard that almost forgotten number. They reached the end of the number and the announcer said it was played by the Silvertown orchestra in Chicago! Well, this couldn't be, I must be imaginning that it what I heard, so I moved the dial a bit and there was a tenor banjo with another orchestra playing, "I'm in Love With You, Honey" . . . The announcer said it was Harry Reeser and the Cliquot Club Eskimos at W G I, Amrad, Medford Hillside! When would I wake up out of this dream—I blinked and swallowed hard—and whirled the dial to, believe it or not—Roxy's gang and little "Gamby" singing, "I've Got a Pain in the Sawdust—" . . . . . My hand was shaking and a voice from another station—yes, from a by-gone time said, "This is Jimmie Gallagher, still hangin' on"—W PG at Atlantic City . . . Next the Miami Beach Hotel—W M B H, then station at Fort Wayne. Holy mackeral, this was too much: I pulled out a cigarette and reached a shaking hand for my lighter on a shelf over the bench. Wouldn't ya know it, it fell from my grasp and hit the tip of the old U V 200 which slowly dimmed and went out and a small spiral of smoke issued out of the broken tip—or did it return to the bottle like the genie I've heard about? I don't know. I've never found another UV 200 and the later U X201A don't seem to do the same. True, I hear many stations on this old time home brew set but since that accident with the lighter—hmmm.

. . . WA1ABP

Accurate *if* Alignment

Harold Mohr K8ZHZ
5670 Taylor Rd.
Gahanna, Ohio 43020

I hear many hams talk of the troubles they have in accurately aligning the *if's* of their receivers, especially some of the newcomers using a converted surplus receiver. I have been using the procedure listed in **Fig. 1** for years, and find that most receivers will come close to reading correct if the *if's* are set correctly before any *rf* or oscillator alignment.

As all American BC stations use 10 kHz separation and are crystal controlled, I use them to check signal generator settings. For instance, suppose I want to align a receiver with an *if* frequency of 1680 kHz. Setting the signal generator at 420 kHz, its 2nd harmonic should zero beat with a broadcast carrier at 840 kHz. Then it fourth harmonic is within a few cycles of 1680 kHz, and is used for the *if* alignment. To align a 455 kHz *if* accurately, I zero beat the signal generator's second harmonic of 455 kHz against a 910 kHz broadcast carrier, and align from the fundamental.

This approach is very accurate, and the signal generator needs a 30 minute warmup before doing alignment work. If the receiver *if* is known to be far off, I do a rough alignment before using this procedure.

if Freq. of rcvr.	Sig. gen. setting	BC station zero beat at:	Harmonic beat with BC sta.	Harmonic for alignment
260 kHz	260 kHz	780 kHz	3rd	Fund.
262 "	262 "	1310 "	5th	"
266 "	266 "	1330 "	5th	"
455 "	455 "	910 "	2nd	"
915 "	305 "	610 "	2nd	3rd
1650 "	330 "	660 "	2nd	5th
1680 "	420 "	840 "	2nd	4th
1750 "	350 "	700 "	2nd	5th

. . . K8ZHZ

Charlie's Broken Dream

The Defeatist Attitude

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Norwalk, Ohio 44857

"Where's that garden rake?" mumbled Charlie. It was dark in the basement and he turned on the light. As the naked bulb flashed on. Charlie was momentarily blinded. Then his sight returned. "I must have put it back by the furnace," he answered himself.

Charlie went back by the furnace, near the hot water heater, and turned on another light, this one flourescent. Then he saw it. It returned to his memory again. There on the bench was that fifty watt cw transmitter, general coverage receiver, and speaker. Two coax cables snaked their way upward to the ceiling and out the hole drilled in the window casing. Charlie remembered.

He moved toward the operating position with care, as if approaching a friend after many years, unable to remember his name. "It sees like only a few weeks ago. . .," he mused. Actually, it was years. Charlie sat down, fingering the key lightly, sending out a series of CQ, CQ, CQ. "Pretty good fist," he thought.

Then he wanted to leave, but his hand was drawn to the switch of the receiver. Soon the sound of the 40 meter novice band reached his ears. "The rig still works. I wonder if I can still copy any code?" But he didn't try. Suddenly he was gripped by a feeling of nostalgia for this hobby that once was his. He tuned the receiver up from the novice band to the phone band. There they were: rag chewing, working DX, handling traffic, and there was a phone patch. Then Charlie looked at the vfo he was never able to use, right next to the home-brew modulator which received the same fate.

Charlie's thoughts wandered to the day several years ago when he went to Baltimore to take the general test. He was nervous then, but thought he could pass the exam. "After all," he remembered thinking, "didn't Joe up the street pass it? Why can't I?" But he didn't. He vowed to return in a month to try again. That time he really felt confident. Failed. What was wrong? He had thought about going back a third time, but he never gotten around to it. It was kind of embarrassing.

About a year after his novice license ran out, Charlie thought about selling his gear at one of the local radio club meetings. Somehow he just couldn't bring himself to talk to the fellows, though. It was like he wasn't one of the group. After all, if you don't have a license, you aren't a ham. He had often seen his dipoles for 80 and 40 meters hanging in the back yard and felt they should be taken down. But it was an all day job to climb up that tree again; the garage roof wasn't as sturdy as it used to be, either. The antennas weren't too obvious, so he just pretended that they weren't there at all.

So the rig sat in a dark, unused corner of the basement, hidden behind the hot water and some old snow tires so Charlie couldn't see it, just as his memories of his days on the novice band were relegated to some obscure recess of his mind, along with the dreams of a general ticket. But every few months, Charlie was drawn by fate to the basement where he was forced to remember.

Charlie stood up and viewed the scene. Dust covered logbook, dog-eared handbooks and magazines, cobwebs guarding the t-r switch, and a few crickets scurrying from the transmitter cabinet. Charlie turned off the receiver and shuffled away. "Now, where's that garden rake?"

. . .WA8VST

Propagation Chart

MARCH 1969

ISSUED JAN. 1

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	7	7	14	21	21	21
ARGENTINA	21	14	14	14	7	7	14a	21a	21a	21	21	21
AUSTRALIA	21a	14	14	7b	7b	7b	7b	14b	14a	14	21	21a
CANAL ZONE	21	14	7a	7	7	7	14	21a	28	28	28	21
ENGLAND	7	7	7	7	7	7b	14a	21a	21a	21	14	7a
HAWAII	21	14	14	7	7	7	7	7b	14	21	28	28
INDIA	7	7	7b	7b	7b	7b	14	14a	14	7b	7b	7
JAPAN	14a	14	7b	7b	7b	7	7	7	7b	7b	7b	14
MEXICO	21	14	7	7	7	7	7	14a	21a	21a	21a	21
PHILIPPINES	14	14	7b	7b	7b	7b	7b	14b	14b	14b	7b	7b
PUERTO RICO	14	7a	7	7	7	7	14	21	21a	21	21	21
SOUTH AFRICA	14	7	7	7	7b	14	21	21a	21a	21a	21	21
U. S. S. R.	7	7	7	7	7	7b	14	21a	21	14	7b	7
WEST COAST	21	14	14	7	7	7	7	14	21	21a	21a	21a

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	21	14	7	7	7	7	7	7a	21	21a	21
ARGENTINA	21	14	14	14	7	7	14	21a	21a	21	21	21
AUSTRALIA	21a	21	14	7b	7b	7b	7b	7b	14	14	21	21a
CANAL ZONE	21	14	14	7	7	7	14	21	28	28	28	28
ENGLAND	7b	7	7	7	7	7	7b	14	21	21	14	7a
HAWAII	28	21	14	14	7	7	7	7	14	21	28	28
INDIA	7b	14	7b	7b	7b	7b	7b	14	14	7b	7b	7b
JAPAN	21a	21	14	7b	7b	7	7	7	7	7b	7b	14a
MEXICO	21	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21a	14	7b	7b	7b	7b	7	7	14b	14b	7b	14
PUERTO RICO	21	14	14	7	7	7	14	21	21a	21a	21a	21
SOUTH AFRICA	14	14	7	7	7b	7b	14	21	21a	21a	21	21
U. S. S. R.	7b	7	7	7	7	7b	7b	14	14	14	7b	7b

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	21	14	7	3a	7	7	3a	7	14	21	21a
ARGENTINA	21	21	14	14	14	7	7	14	21a	21	21	21
AUSTRALIA	21a	28	28	14	7a	7	7	7	14	14	21	21a
CANAL ZONE	21	21	14	7	7	7	7	14	21a	28	28	28
ENGLAND	7b	7b	7	7	7	7	7b	7b	14	21	14	7b
HAWAII	28	28	21	14	7	7	7	7	14	21a	28	28
INDIA	7b	14a	14	7b	7b	7b	7b	7b	7	7	7b	7b
JAPAN	21a	21	14	7b	7b	7	7	7	7	7b	7a	21
MEXICO	21	14a	7	7	7	7	7	14	21	21a	21a	21a
PHILIPPINES	21a	21	14	7b	7b	7	7	7	7	14	7b	14
PUERTO RICO	21	21	14	7a	7	7	7	14	21a	28	21a	21a
SOUTH AFRICA	14	14	7	7	7b	7b	7b	14	21	21a	21	21
U. S. S. R.	7b	7b	7	7	7	7b	7b	7b	14	14	7b	7b
EAST COAST	21	14	14	7	7	7	7	14	21	21a	21a	21a

A. Next higher frequency may be useful.

B. Difficult circuit this period.

Good: 1, 2, 5, 6, 9-13, 15-20, 26-28, 30

Fair: 3, 4, 7, 8, 14, 21, 24, 25, 29

Poor: 22, 23

(Kluge Tube)

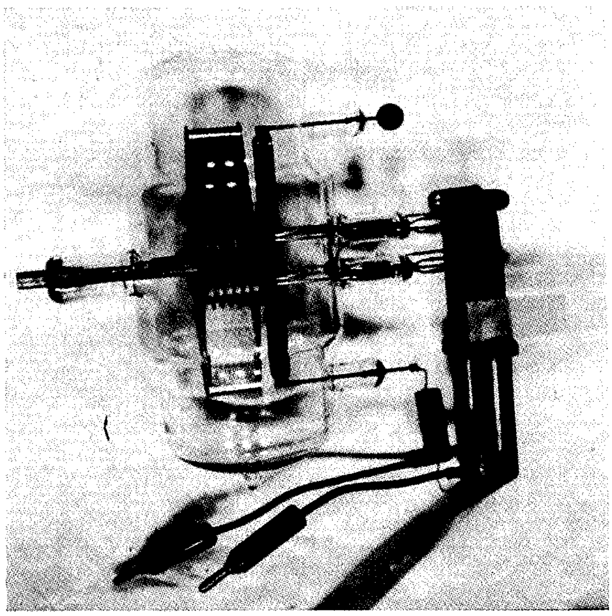


Fig. 1. The remarkable radar tube. From the dimensions of the quarter-wave lines that provide electrical and mechanical continuity, it appears this tube is designed to oscillate around 1200 MHZ. It comes with an 80-ohm grid resistor, far too low for amateur applications.

There is a term for something big, odd, and not very useful. I heard it recently; it is "kluge.' Since I am writing about a thing properly called a kluge, naturally this is a bit of kluge copy.

But hold on a minute . . . a good idea is still a good idea even though it may be out of date, or obsolete a few times over. See **Fig. 1.** Here is our kluge, and it certainly is one of the most awesome things I've ever pulled out of a big box.

This thing is a VT-158. Developed just before or early in WW 2, it is a UHF oscillator tube, with about two-thirds of the oscillator circuit inside the tube envelope. At peak powers in the 250 kw range and at frequencies in the order of 1000 MHz, the tube simply could not be constructed in an orthodox way. All that is a very interesting story, in which the development of the tube opened new technological fields, and the tube itself affected the course of WW2.

But what can you do with it now?

Maybe you can set it on your mantle as a conversation piece. (keep it away from children; it's full of vacuum and sharp edges) A museum might be interested, or it's a rather fantastic thing to look at. Something like reading a chapter of a book on high-frequency techniques. It's a lesson in itself to simply work out why this tube is built the way it is. But how about this?

Taking a fresh look, let's recall some vacuum tube theory. If we go to a lower frequency or think in dc terms for a bit, this amounts to one triode with the same amplification factor as any of the four triodes inside the envelope (since they are all similar) but with one quarter the plate resistance.

We will have to measure the plate resistance, but the mu is simply a measure of the effectiveness with the grid competing with the anode in controlling the anode current. A ballpark figure is available by looking at the tube; since the accelerating field at the heater surface is the sum of the grid and anode fields, and the grid is about three times closer than the anode, the mu is about two or three.

This tells us cutoff bias for class C operation will be terrific. At 800 volts on the anode, grid bias should be in the 400 volt ballpark. Remember we aren't using this as

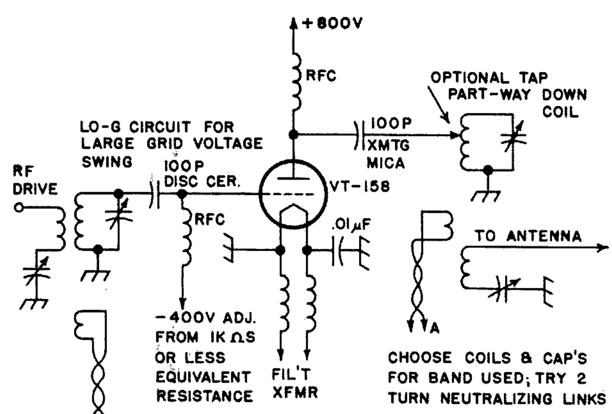


Fig. 2. Suggested schematic for an old idea power amplifier. Operating class C it should generate TVI as well as anything on the air, but it may be possible to operate linear quite effectively.

the manufacturer intended! That means we can use the same power supply for grid and anode, taking a little minus straight off the high voltage winding.

We don't want to try a really high voltage because with the greater heater area and fantastic emission capabilities (250 kw peak) the anode resistance is probably quite low once we've defeated the space charge. Can we make an amplifier out of this?

I think so. Its internal structure is a bit of an obstacle, and so we cannot use it in a tuned-line circuit. But on the lower bands the four triodes will get by as one, and you can even go to link neutralization again. Heater power is a bit high, but, after all, you can pare that down if you don't reduce the emission too much, and this old broadcast engineer's trick increases the life of the tube.

Anode dissipation is a big question. It is probably several hundred watts, and the grids can run approximately white hot, so should be durable enough in amateur service. Just keep on remembering those 250 kw peak power ratings!

A proposed schematic appears in **Fig. 2.** Remember, this hasn't been tried, yet, and is based largely upon an eyeball estimate of what the tube might do. Let us know how it works out!

The VT-158 is available from United Radio. See ad on pg. 61. ■

Amphenol Opens Up the Parts Market

As you walk in the door of your local parts distributor you may intend to buy a single component. But the distributor must bear many costs and wants to sell you ten or a hundred, all the same. This conflict of interest was resolved very nicely several years ago, by the idea of "amateur privilege." That is, anybody with a ham ticket in his pocket could go to nearly any wholesaler and pick up what he needed at wholesale prices.

Those days are gone. Discount stores selling to anybody who walks in the door, rising prices and costs, the advent of big money in the TV, hi-fi, CB and automotive electronics fields have jointly confused the idea of "amateur privilege" until at this point anybody under 30 or so probably has never heard the term.

Faced with competition and a growing consumer market, a few wholesalers and retailers have tried packaging as an answer to the sales problem. "Sell a pack of several; it's not hundreds but it's a sale which somebody is going to make" is the idea, and a bit of modern technology has provided an answer to the problem of inexpensively packaging things. The answer is the Blister-Pak.

Previous efforts have not been successful because the packages cost too much. But the Blister-Pak system has emerged as a fast, automatable system which packages items at the least possible cost. Prices need not be much above those of the fellow down the street who sells the same parts out of a dirty old box. And useful circuit data can be included in the package, compensating for the slightly higher prices and making up a very salable item.

The result of this new approach, which is based on two years of market research, is appearing in the form of rotating self-service racks in distributors' showrooms. If you need something, you go to the appropriate rack and choose what you need or a reasonable substitute, and when you're done shopping you make just one trip to the counter. This Blister-Pak idea is likely to prove a really big boost in the parts sales business, and will offer greatly increased convenience to shoppers.

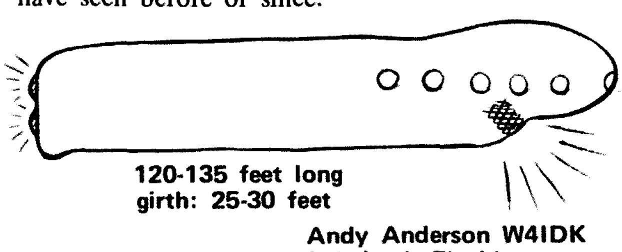
Amphenol is presently marketing 53 different blister-packaged components, including a variety of connectors, directed to the needs of radio amateurs, stereo and hi-fi fans, and even CB'ers. There are also audio adapters, and even in-line lightning arrestors, with more to be added later. Free hobbyist booklets, provided on the displays, are designed for handy workbench reference. For more detailed information, contact Amphenol Distributor Division, 2875 South 25th Ave., Broadview, Illinois 60153. ■

LETTERS

Dear Wayne,

On July 21, 1968 I was working on the 4-12 shift. I left Bartow, Florida to return home in Lakeland at about 12:15. This trip takes about 15 minutes at normal speed, so I judge that it was near 12:35 am when I got home. I parked at the house and stepped out into the drive to take a look at the weather. It was very quiet and I could hear a strange noise as if there was a sharp breeze coming in. I looked up in time to see the cause of this swishing sound. I saw a disc about 20-25 feet across traveling from south west to north east at about 100-150 feet up. It was inclined slightly lower on the forward direction with a slight tilt to the right. It appeared to be of a fairly bright metal much like annodized aluminum. It had a black or dark ring about 4-5 feet in from the edge that looked to be about 2-3 feet wide. I got a good look at it for it was not going at a high speed. There was no other sound than the wind caused by the passage of this object through the air. Had it not been so quiet I would not have been able to hear it at all. There was no light coming from it at all, but it was plainly visible in the reflected light of the street lights. Apparently I was the only person to see this one so I can only give an unverified report on it.

I can give a verified report on an earlier sighting together with a drawing made by the four people at the time. I was the manager for the Bordon plant in Lakeland and attended a sales meeting in Clearwater with my office manager, sales manager, and the supervisor from the plant. When we were driving back we saw a very bright blue light approaching from the east. It appeared to be coming lower and the light got very bright. There was a very bright full moon and the road was almost empty of cars. As this object appraoched we stopped the car, shut off the motor and got out. It passed about 500 feet south of the road at an altitude of 500 feet. I could plainly see the curved band of very bright blue light just aft of the nose on the lower front. A series of very bright portholes extended at midpoint of the body and appeared to go completely around the nose. There were two pale glowing domes on the rear of the body. This object made no noise at all and THERE WERE NO WINGS. It passed between us and the moon. Our observation point was between Tampa and Plant City on what is known as Dover Flats. As we watched the object which was traveling very slowly (perhaps 20 mph), it speeded up and disappeared in just a few seconds. We decided to each draw what we had seen without discussion. Below is the drawing as it appeared to us. Our estimates were very close. I have seen many odd shaped planes and blimps, but this was nothing like anything I have seen before or since.



120-135 feet long
girth: 25-30 feet

Andy Anderson W4IDK
Lakeland, Florida

Dear Wayne,

Very seldom do I write a letter to anyone, especially to thank them for a service rendered. The service I am thanking you for is the much enjoyment 73 has provided me over the past few years. I take all the popular amateur publications and I must say that 73 is by far the best. It seems as if the articles are very timely with projects I would like to build or information that I need on one of my own ideas. Just keep up the good work and print what hams want to know.

Bob Budsong WA4SLG
College Park, Georgia

Dear Kayla,

Sorry, but just hafta send another one of those nice letters! 73 was the first publication that I got acquainted with after getting my Novice, although I had seen the others. I really appreciate 73, both editorially and technically. I realize that thousands of readers have a like number of ideas or desires, but I like the basic policy that 73 is for us and not trying to establish some kind of ecclesiastical headquarters. My two desires are that you continue to keep us advised as to what is pending in ham radio and stuff that we can read and build in order to advance ourselves. My only complaint is that 73 comes only once a month and should be twice as large! Hi! One other comment: whatever you do for the Novice and new General now will be remembered when we are Extras. Thanks so much for the efforts of the staff.

L.E.Thompson
Eau Claire, Wisconsin

We could publish twice as many articles if the advertising would support it. It is entirely up to you, the readers, to impress on the manufacturers and distributors that you are looking for their ads in 73 and not in the other magazines.

Gentlemen,

I wish to take this opportunity to compliment the entire staff of 73 Magazine for their efforts and dedication to Ham Radio, by the absolutely excellent series of articles, "Getting A Higher Class License." These articles have helped me personally and I'm sure untold thousands of other Hams in really understanding the "hows and whys" of our equipment. Keep up the good work.

James Hall WA8SED
Miamisburg, Ohio

Dear Wayne:

To kill some time, I happened to page through "The Index to Articles Appearing in 73 Magazine in 1968." Articles such as "Tuning in on Bonadio's Satellites," "An Invisible Antenna," "How to Write for Service Information," "I Rode With the (excuse the expression) CB's," and "A Space Communications Odyssey" really turned me on. In my mind, these types of articles are the ones that make your magazine very worthwhile and interesting. However, to keep you from getting a big head, I feel your construction articles usually are somewhat in left field, and I'm an Extra Class ham that likes to homebrew things.

Leland L. Bahr, W9DRC
Park Forest, Illinois

Open Letter

The annual ARRL Board meeting will be held in May. It is now time to advise your Director of your wishes regarding matters to be acted upon at this meeting.

There is an international telecommunications conference scheduled for late 1969 or early 1970. This meeting concerns the UHF/VHF. It is expected that all amateur bands in that spectrum will come under extreme scrutiny and perhaps some drastic changes (or possible losses) will result.

It is of vital importance that the usage of the UHF/VHF be increased, and that the results of amateur communications on these bands be widely publicized, in all media. This is the year of VHF/UHF if we expect to hold these frequencies now allotted to us.

It may be already too late, but the effort must be made by ARRL and the amateur body.

Probably the most effective demonstration of these frequencies can be made thru EME communications. This 1969 ARRL Board of Directors should act to place ARRL in the strongest possible position in this vital field of amateur endeavor. This 1969 Board must act, and quickly!

In 1967, the ARRL Board allotted the piddling sum of $1500 for an "ARRL Space Station." This ridiculous amount for such a worthwhile and necessary project is actually an insult to the fine VHF/UHF work being done by others.

ARRL should appropriate whatever is needed, even if it costs a hundred or more thousand dollars, to equip and to staff an adequate EME ARRL station--if ARRL is to live up to its self-appointed role of leadership in amateur radio.

ARRL must have such a station now to help others in this work and prove that ARRL is actually interested in UHF/VHF work. ARRL's attitude toward these frequencies has been less than enthusiastic in recent years.

A state-of-the-art, legally-powered EME station operated on a 24-hour basis by ARRL would surely focus attention on these activities and would serve all amateurs world-wide in their efforts on EME--if only to listen to ARRL's EME station, such as many do to W1AW.

It is pathetic that ARRL with its many kilobucks in stocks and bonds has not already acted to build and staff an adequate EME station. However, it appears that ARRL Board action will be necessary to force HQ into action (there has been no visible result of their 1967 directive) to put ARRL into the VHF/UHF field. Such ARRL participation, long overdue, should be immediate and totally effective--and 1969 is the year to do it.

It is typical of ARRL HQ disinterest and lack of action that most of the marvelous work done on EME and other significant VHF/UHF work has been done by individuals or small groups without vast monetary resources, such as the ARRL has available.

The 1969 ARRL Board should take action to force HQ to support the NASTAR project (to place a ham station on the Moon on the first or second manned landing) which has NASA approval. ARRL should contribute money (in substantial amounts), as well as technical and publicity aid to NASTAR. (Note: There is no reason why it should require Board action to get HQ to do such things, but since it does--it is up to the Board to take whatever steps are necessary.)

If the ARRL Board does not take action (1) to provide funding for a meaningful ARRL EME facility (2) to provide substantial monetary aid and support of NASTAR--then this Board will be shortchanging the ARRL membership and amateur radio. If ARRL is ever to take a positive stand on VHF/UHF, it is now, 1969. And, this Board must see the job done properly!

Second only to the ARRL Space project is the long-overdue staffing of an ARRL's Field Representative department. This was ordered done by a past Board but nothing has been heard of this directive since. There is a vast gap between ARRL HQ and the ARRL membership (in personal contacts) and an even wider credibility gap exists between ARRL and non-member amateurs. This gap is widening.

ARRL HQ (through Board action, if necessary) can subsidize (through partial or total payment of personal expenses) the attendance of incumbent and former ARRL elected officials such as SCM's, directors or vice directors, at every ham gathering from a local club to a hamfest or convention.

An ARRL representative must be present to officially "show the flag" at every type of gathering where amateur radio and ARRL should be discussed. There are plenty of incumbent or former ARRL officials to handle this, and they should be accredited and equipped to do so. These ARRL Field Reps could collect information to be passed on to HQ or the respective ARRL officials, they could pass out ARRL literature and in general "pass the word" regarding ARRL.

At the SAROC in Las Vegas this January, there were over 1000 persons registered from 33 states, Canada and even some DX. The Pacific Division ARRL Director was present, circulated around, and held a meeting which was listed on the program. There was no ARRL booth or recognition on the display floor of ARRL or QST. ARRL QST was conspicuous by its absence in the presence of well-staffed booths operated by 73, CQ and HAM RADIO, plus QCWA, OOTC and MARS. There were no ARRL publications on sale at SAROC. The other magazines had elaborate displays and material for sale.

There are far too many licensed amateurs today who have little or no contact with ARRL. They do not even subscribe to QST, nor care about ARRL! They are ignorant of ARRL and it is ARRL's fault in that it is not officially represented at all ham gatherings.

What can you do about these matters? If you agree that something should be done--write a letter to your Director and send copies to your Vice Director and to ARRL HQ--attention Secretary. Request that your Director-representative take every action necessary to secure the adoption and success of these two important features--in 1969.

Also, request that your director second or support measures brought up by other Directors at the Board meeting that will lead to a more progressive attitude and total effort by ARRL and ARRL HQ.

A recent check at 73 revealed that only three of the sixteen ARRL Directors subscribe to 73 Magazine so it is necessary for you to call these matters to their attention. Editorials in QST repeatedly state that the Directors are "your representatives and that they welcome your suggestions." If this is true, and you make requests concerning this, then some action should result at the 1969 Board meeting that will be meaningful.

A. David Middelton, W7ZC
Former ARRL Director

... more Letters

Dear Miss Bloom and Mr. Green,

Since you have accepted an unsolicited article submitted by me, I hope that you will also accept this unsolicited compliment. The speed with which you reviewed and came to a decision upon my piece is something amazing in the annals of publishing. Needless to say, I consider your payment more than adequate and perhaps about twice what the article is worth. Your timing was perfect, as earlier in the day your check arrived I had committed myself to a new transmitter. The article won't pay for it, but it does make a tidy down payment on it.

Again, thanks for your prompt consideration and decision. I shall probably submit something in the future when I feel I have something to say and shall look forward to your efficient editing, even if you have to tell me it isn't worth its weight in sand.

L.B.Cebik, W4RNL
Athens, Georgia

Dear Wayne and Kayla:

I don't know if the shortage of articles on FM is due to a lack of editorial interest, or a lack of contributors. I personally think that FM as a mode of operation and things like repeaters will be the salvation of the ham world above 30 MC. At the N. E. Michigan hamfest, I attended an FM talk which included a slide show and recorded tape presentation about the Tulsa Repeater. As a ham who, until recently, has had little or no use for the VHF and UHF bands, I was astounded with what the Tulsa group had accomplished.

The recently formed "Great Lakes Repeater Association" has (or will shortly have) a repeater for the metropolitan Detroit area members. I recently obtained a Motorola 2M FM rig, and find that there is more to it than bolting it in and hooking it up. There is not a lack of talent in this area for putting it in operation. I expect to have it in operation soon.

But what about hams in other areas? How about a two or three month series on "Basic FM Theory?" True, there are conversion and schematic digests available from various sources, but they cover specific pieces of surplus gear. They are sadly lacking in basic information which applies to all FM gear.

So may I suggest a few basic articles on FM theory, or at least a few questions and answers in the staff articles on getting the higher licenses. It would be a step in the right direction, and another chance to get ahead of QST!

Keep the fine magazine coming every month.

Ralph O. Irish, Jr., WA8GDT
Utica, Michigan

(Authors take note)

Dear 73 Staff,

I was fortunate to have several of your 73's available to me with the study guide for higher class licensing. By using them along with other material, I did pass the Advanced test with very little trouble. I cannot praise your articles enough. They are written in a language that even I, a common housewife, can understand. I especially appreciated the humor along with the serious. I thank you very much.

Lyla KL7CSR
Spenard, Alaska

Dear Madame,

On or about January 1, 1969, the premises of the Grumman Amateur Radio Club were broken into and the following listed equipments were stolen:

Collins 32S-1 transmitter, Serial No. 10891
Collins 75S-3 receiver, Serial No. 10779
Collins 312-B-4 station control, Serial No. 52496

Publication of this information will be appreciated. It may be instrumental in the recovery of the loss. Please notify the undersigned or the authorities of any information leading to the recovery of these items.

Emmett Goodman, Sr., WA2JFA
Grumman Amateur Radio Club

Dear Wayne,

Just a note to applaud your suggestion of a UFO net! Ham radio has needed something like this. If this doesn't get picked up and something done about, we'd all better become CB'ers and give our ham bands to the highest crass commercial bidders.

Waldo Boyd
Geyserville, California

ODE TO A HAM

I notice when some fellow dies
No matter what he's been
Some saintly chap,
Or one perhaps
Who's life was stained with sin
His friends forget the bitter words
They spoke but yesterday
And now they think of a multitude
Of pretty things to say.
Perhaps, when I am laid to rest
Someone may bring to light
Some noble deed
Or kindly act
Long buried out of sight.
If it's all the same to you, my friends,
Just give to me instead
A clear frequency while I'm living
And the QRM when I'm dead.

Pete Fragale W8AEN
Clarksburg, W. Va.

UFO BOOKS

UFOs: A New Look, published by NICAP. This book gives dozens of well documented recent sighting cases and tells the inside story of the Condon "whitewash" report. If strange little men in "space suits" are not visiting our planet, then a lot of reputable people have suddenly made up similar tales in many parts of the world. Absolutely fascinating book. $3.00 in U.S., $4.00 foreign. NICAP, 1536 Connecticut Ave., N.W., Washington, D.C. 20036.

The UFO Evidence (1964, 128 pages). Published by NICAP at $5 U.S. and $7 foreign. Hundreds of carefully researched UFO sighting cases. This is the definitive book on UFO sightings by responsible observers. Can anyone remain a sceptic after reading this report?

The UFO Investigator, a newsletter published bimonthly by NICAP. $8 per year, including membership. This is the most unbiassed report on UFO sightings and events. Each issue is worth its weight.

Projects Grudge & Blue Book Reports (USAF case histories and analyses) published by NICAP. $5 in U.S. and $7 foreign. One can only ask how, with reports like this to work from, our Air Force can pretend that UFOs aren't there.

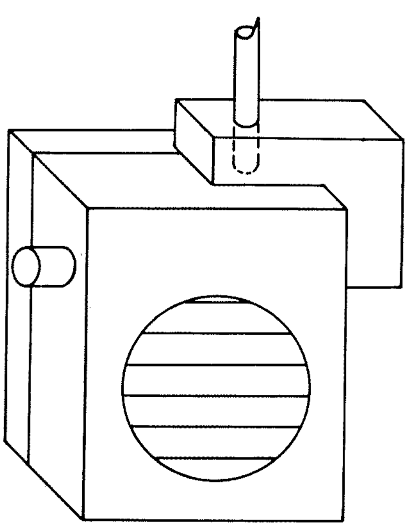
For Those Who Think Small

and Other Hints

David B. Cameron WA4VQR
324 S. Riverhills Dr.
Temple Terrace, Fla. 33617

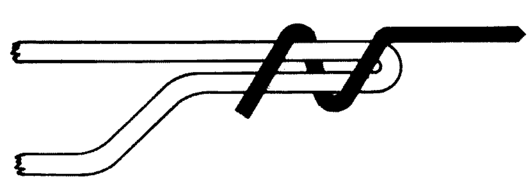
Hams have found that "walky-talkies" can be converted, with a little Yankee ingenuity, into low power 10 meter mobile units, transmitter sniffers for hunts, monitors, and other similar gear that doesn't need much punch. A popular source of these mini-rigs for the money minded ham has been imported oriental gear that can often be bought on special sale for as low as five bucks a unit. Unfortunately, many of these units share a common structural flaw. In an effort to produce the units as cheaply as possible, many manufacturers have the antenna screw in at the top. For the ham who parks his gear in the shack all day, this is fine, but the poor fellow who takes his out may find that that long light antenna grabs for trees and bushes like they were home. The next thing he knows he has an antenna broken off at the bottom or a plastic case cracked where the threaded antenna receiving piece is attached. All he can do is mutter that God shouldn't have made trees, electronics, or the Japanese. There is something that can be done before this happens (or after if you're really stubborn). Take a piece of plastic, ¾" thick, cut it as shown in **Fig.** 1, and drill the required hole where the antenna will fit. The antenna support will help some if just set into position, but will be stronger if cemented there. Two things to watch, the distance from the antenna to the side of the unit must be measured accurately to insure a good fit, and the hole for the antenna must be large enough to allow a sliding fit without much play. This may mean that if your antenna is an odd size, you will have to drill a small hole and enlarge it with a rattail file. Now, on the other hand, if you want a beam antenna, you're on your own!

. . . WA4VQR



Soldering Tip Top

One of those necessary parts for the ham shack that is hard to remember when you are in the parts store is a new soldering tip. Like many hams, I have, for a long time, used short scrap pieces of large diameter bare copper wire (#10-#14) instead of commercial soldering tips. With the invasion of transistors in ham technology, I was faced with the choice of either burning my fingers with one of these constant heat soldering pencils or overheating the components with my large gun because the tips were too big and too hot for the circuits. I solved the problem by making tips with # 12 wire, then taking about a two inch length of the same size wire, wrapping half of it around the end of the tip and leaving the other half protruding. This forms an indirectly heated tip, with a lower temperature that can be varied by adjusting the length of the single wire that extends beyond the end of the loop, just as the temperature of the old-fashioned electrical soldering irons is controlled by sliding its moveable tip in and out. The tip can go into the smallest circuits, but won't sit on the bench smoldering when not in use.



David B. Cameron WA4VQR

A Report on the WTW Award

Since Gus is leaving for another DXpedition soon, Dave Mann K2AGZ will be the new custodian of the WTW. Files are in the process of being transferred at this time. Address all WTW correspondence to Dave at 1 Daniel Lane, Kinnelon, N.J. 07405

Gus Browning W4BPD

For those of you who are not familiar with our WTW rules. In brief they are basically:
1. All QSO's must have been since May 1, 1966, 0001GMT
2. All QSO's must have been on one band & mode (SSB, AM, NBFM all considered phone)
3. Separate WTW Certificate for the following:
   a. 100 countries on CW-28Mc WTW-100-28 Mc CW certificate
   b. 100 countries on Phone-28 Mc-WTW-100-28 Phone certificate
   c. 200 countries on CW 28Mc WTW-200-28-CW certificate
   d. 200 countries on Phone 28 Mc WTW-200-28 Phone certificate
   e. 300 countires on CW-28Mc WTW-300-28-CW certificate
   f. 300 countries on Phone-28Mc-WTW-300-28Mc Phone certificate
   h. 350 countries on CW-28Mc WTW-350-28Mc CW certificate
   I. 350 countries on Phone-28Mc WTW-350-28Mc Phone certificate
4. You can qualify for the above certificates on each ham band. But I have my doubts how long it will take someone to qualify for that WTW-350-CW on 28 Mc! But it is possible for a real go getter to earn, lets say, 4 certificates on 10, 15 and 20 meter bands.

In looking over the claimed scores that are being submitted to me for our honor roll I can see the interest building up in quite a number of different bands and modes. With the very FB conditions on the various bands I can see a number qualifying for their next higher WTW award—One certain fellow is getting very close to WTW-300 and I think he probably will have the cards on hand by next month and a couple of other stations are just behind him, so you see fellows—it's possible to make WTW-300 in just a little over 2.5 years of operation and "going after" QSL cards.

Any of you DX stations let me again remind you that there are many W/K stations that would like to become your QSL manager and many of these QSL managers actually pay to have your QSL cards printed themselves. The idea of DX stations getting a stateside QSL manager should solve the problem of QSL cards once and for all time. So pass the word around to your DX friends and tell them the many advantages of having a QSL manager. This would automatically eliminate the burdens of QSL's to those who have trouble with both money and time in sending them out.

THE WTW HONOR ROLL

7 MHz—CW:	W4BYB	151 countries
	W3WJD	100 countries
	W8ZCK	100 countries
14 MHz—CW:	K4CEB	102 countries
	W8EVZ	102 countries
	W4CRW	101 countries
	WA2DIG	100 countries
	K8IKB	100 countries
	WB6SHL	100 countries
	W9HFB	100 countries
	WB6NWW	100 countries
	W5ODJ	100 countries
	WB2TKO	100 countries
	WA9KQS	100 countries
	W1ETV	100 countries

	K5BXG	100 countries
	K4ASU	100 countries
	WA6GLD	100 countries
	W2UGM	100 countries
14 MHz—Phone:	K8YBU	291 countries
	WB2WOU	266 countries
	W4NJF	261 countries
	WA5LOB	247 countries
	W6MEM	245 countries
	W3AZD	226 countries
	XE2YP	209 countries
	WB2NYM	204 countries

Following all at 200 countries: W1MMV, K6CAZ, K3YGJ, W3DJZ, W2PV, PY3BXW

	W8BVF	192 countries
	WA5DAJ	187 countries
	W9KQS	161 countries
	VK3XO	153 countries
	W6YMV	150 countries
	WB2RLK	138 countries
	K2QOU	125 countries
	WB2NSG	122 countries
	K4GXO	120 countries
	K1SHN	111 countries
	W1SEB	110 countries
	W4TRG	106 countries
	WA4OPW	105 countries
	SVØWL	105 countries
	WØSFU	104 countries
	W3SEJ	103 countries
	CN8FC	103 countries
	VE3ELA	102 countries
	VE6AKV	102 countries
	K4VKW	102 countries
	W6OHU	101 countries
	W8WAH	101 countries
	WAØOAI	101 countries
21 MHz—CW:	W4OPM	100 countries
	WB2UDF	100 countries
	VE6TP	100 countries
	WA6GLD	100 countries
	WØRRS	100 countries
	WA9OTH	100 countries
21 MHz—Phone:	W4OPM	220 countries
	W6MEM	161 countries
	WA2FQG	155 countries
	WA5LOB	154 countries
	WA5DAJ	130 countries
	W9NNC	125 countries
	W8WRP	106 countries
	W2PV	104 countries
	WB2RLK	103 countries
	K5HYB	101 countries
	W2VBJ	101 countries
	K4VKW	101 countries
	WB2OBO	101 countries
	K9PPX	100 countries
	W6YMV	100 countries
	WA4WTG	100 countries
	WAØOAI	100 countries
	WA1EUY	100 countries
	WA8VFK	100 countries
28 MHz—Phone:	WA5LOB	136 countries
	W6MEM	129 countries
	WA5DAJ	117 countries
	W2PV	106 countries
	W2VBJ	104 countries
	WB2RLK	100 countries
	W4GJO	100 countries
	W5YPX	100 countries

Great starts here for some very interesting battles in DXING. If I have your score wrong please drop me your latest CLAIMED SCORES—not QSL cards—BUT WHEN you hit the next plateau in the WTW then you are to submit QSL cards to your WTW QSL check-point—if no point send them to me.

We now have a WTW Check point for W2/K2 land: Peninsula Amateur Radio Klub, Foot of 25th. Street, Veteran's park, Bayonne, New Jersey 07002.

MAIL ADDRESS: P.O. Box 531, Bayonne, N.J. 07002.

Still looking for a good Club in W1/K1 land—How about it fellows? Next month we will give the whole list of WTW check points.

. . . W4BPD

(...de W2NSD/1 continued from page 4)

amateur radio has been stifled, the country has suffered tremendously from a lack of engineers and technicians and has found it difficult to develop their communications and electronics industries.

In numbers we have strength and we need that strength badly. The time is drawing near when we will have to either fight for our frequencies or else watch them dwindle away as they have in the past. The time is here right now when we must organize our effort. What would our bands be like today if earlier amateurs had only made an effort to hold our allocations? Through complacency and laziness our "leaders" managed to lose 70% of the 40 meter band and 65% of the 20 meter band. Both of those bands used to be a megacycle wide, you know. They were given up without a battle and look at the mess that is left of them today!

What Can Be Done?

Every amateur who has the interest to try and help can do something to keep us from losing more frequencies. Something can be done right now, today! As a matter of fact, a month from now may well be too late. If every reader of 73 got on the air and talked one or two more amateurs into helping, the result would be a wave that could not be ignored.

If we are going to get amateur radio back into a growing institution we must make a major effort to interest more youngsters in our hobby. We need growth. We need to sell high school students on the fun of ham radio. This can be done in several ways.

First and foremost we need a strong campaign of national public relations and publicity. We need to have articles telling about the fun of ham radio appearing in Life, True, Look, Playboy and other national magazines. There are plenty of good ham writers and a wealth of material; all that is needed is one good man with PR experience and connections to organize the project. A good man will not be inexpensive, of course, and this means that an investment has to be made.

Perhaps you feel as I do that national publicity for amateur radio is a responsibility of the ARRL. They have the money right at hand to fund the project. They have the PR material at hand. They would seem to be the logical organization to work for the growth of ham radio. If this seems reasonable to you then why not get in touch with your ARRL Director and tell him that you want him to see that the League sets up a PR man or company to promote amateur radio. This is a very good time to dip into that over a half million dollars that is just sitting there in the bank and make it work for the survival of our hobby.

The next Board of Directors meeting is in early May, so you have only a few weeks to make yourself heard by your director. You actually only have a few days because your Director is supposed to send all proposals that he is going to make to HQ 60 days or more before the meeting. There is only one Board meeting a year so if you put off getting in touch with your Director for a few days then it won't make much difference and you will have lost your chance to have your say and make things happen

Perhaps you are not an ARRL member or the chap you work on the air turns out not to be a member. This is indeed likely, since only about 30% of the amateurs are ARRL members. This makes no difference. You can still have your say. Check in QST for the name and address of the Director of your area and call him or write to him and tell him that you are not a member, but that if you get the action you want, that you will think a lot more about becoming a member. Everyone works a lot harder for the dollar he doesn't have yet, believe me. The League is hurting and hurting badly for members. I think they will listen to you.

Writers like Jean Shepherd, K2ORS, who has won the Playboy prize for three years running for humor, could be egged into writing wonderful articles extolling amateur radio. But someone has to organize the effort and see that the stories and articles are placed where they will do the most good. Bandel Linn, K8LAP, who has done cover cartoons for us and occasionally scabs a cartoon for QST, is a nationally known cartoonist and could turn out ham-oriented cartoons which would help make ham radio a household word.

One good PR man with a reasonable budget could change the direction of our growth chart from the disasterous to the unprecidented. The ARRL Directors have for years been putting money aside for a rainy day. Is it going to get much more rainy than it is right now? If they just spent the money

their nest egg *earned* each year for PR things would spurt ahead. The stock market, on the average, has been advancing at about 12% per year for many years now. 12% of $575,000 (last reported ARRL statement) would give $69,000 per year.

The money is there to use and now would seem to be one of the best times to use it. The question is, can you talk your Director into getting off dead center and getting this money working for ham radio? It is up to you to move your Director. Call him. Write to him. Talk to him if he sticks his nose into a club meeting in your area. Put on the pressure. And if you don't get some action, give serious thought about getting someone into the position next year that will listen to you. With just a little interest and effort on your part you can make things happen.

Washington Office

For many years I have pointed out that amateur radio is weak because we have no representation in Washington. We are so far out on the FCC organization chart that most Commissioners are not really aware that we exist, much less are important. When the Incentive Licensing proposals were sent in by the ARRL and hundreds of amateurs went to the trouble of writing in their opinions of the action to be taken, how much consideration did we get? The League Board wrote to the FCC asking for "leadership and guidance" and what did they get?

We got just what we paid for and deserved. We got shrugged off. Our problem was farmed out to someone who knew little of our problems and who, apparently, cared less. There is no sign that the hundreds of comments filed on Docket 15928 were even read or noted. The end mish-mash was an amalgam of the RM's filed and reflected little of the comments on the RM's.

The services of an attorney to file proposed rule changes with the FCC are needed and we have them in the body of the ARRL Counsel, W3PS. But amateur radio needs more than that. Far more. The seat of power in our country is in Washington and the seat of power in Washington is in Congress. The FCC works under the direction and funding of Congress and don't think that one person on the FCC staff forgets this for a minute.

The system that is being used for getting action in Washington now is one that works and works well, whether we approve of it or like it or not, and that is the lobby system. Any group that has a common interest that they want to seriously protect goes to the trouble and expense of having someone represent them to Congress. Most hobby groups that depend in any way on government legislation or direction have a strong lobby working for them in Washington.

You know very well about the work that the National Rifle Association has been doing. You have undoubtedly heard about the Aircraft Owners and Pilots Association. I remember a few years back when AOPA decided that they wanted a law made so that foreign pilots could use their radios when in the U.S. In a matter of weeks they had the new legislation through Congress. It took us years and the personal friendship of Barry Goldwater to get a similar bill through for ham reciprocal licensing.

Lobbying is tightly controlled by law and it is highly illegal for the ARRL Counsel to lobby for amateur radio in Congress. We need a registered lobbyist in Washington for our own protection. We don't need anyone terribly expensive. There are probably dozens of hams in the area that have had many years of experience in working with our government that would be proud to work in our behalf as lobbyists. I know that if I had managed to round up something on the order of $20,000 a year with the Institute I could have had someone working full time for us in Congress and also with the other government agencies that influence our future.

The next ITU frequency allocation conference is coming over the horizon and there are a great many things that amateur radio should be doing in preparation. One of the key points of pressure at a conference such as this is a solid U.S. delegation. This means that the delegates from our country must have orders from their agencies that amateur radio is to be protected. We did not have this support at the last conference. Amateur radio was *last* in line for frequency protection. Oh, there was a lot of beautiful oratory about the value of amateur radio, but when it came down to who got what in a frequency exchange, we came last every time. If we have Congress behind us you can bet that our order of importance will be much higher.

What *Can* Be Done?

Tell your ARRL Director that you and

your club want him to see that the League opens a Washington office, even if it is in the bedroom of a local ham. Tell your Director that you want to be represented in Congress. Tell him that you want action now, not a study of the feasibility or any other put-off. Point out to him that all of the other users of radio frequencies are in there putting on the pressure not only to hold what they have, but to take as much of our channels as they can.

Explain to your Director that with everyone else pushing against us and us not pushing back, there is only one way that things can go. Let him know that you remember that this happened to us before in the past and that despite repeated assurances that everything would come out all OK, our amateur bands were cut to shreds. Ask any old timer what it was like when they lost the major portions of 20 and 40 meters.

Remind your Director that at the last ITU meeting in 1959 most of the nations of the world officially requested serious cuts in our amateur bands and that only a most remarkable circumstance enabled us to put off the day of reckoning. Remind him that since that day the Asian and African countries have gained control of the ITU and they are not amateur radio oriented. Remind him that India requested that the amateur radio bands be reduced to 20 kHz width. Tell him that the time is here, right now, for him to speak up at the Directors meeting in May and demand that amateur radio have a lobby in Washington.

The ARRL is the *only* organization you have. You decided that it should be this way when you supported only one organization. Now make that chosen organization work for you. The Directors are supposed to run the ARRL and make the decisions. You are supposed to guide the Directors in their actions. Guide... be heard...get action.

SAROC

After hearing how much fun everyone has had in the past at the SAROC Convention in Las Vegas, I decided that I'd better throw caution to the winds and make the trip. It turned out to be true...I did have fun. So did Lin. We laughed ourselves silly at Buddy Hackett and his dirty jokes...Lin won a few dollars on the nickle machines...I lost it back on the crap tables. We wandered all around Las Vegas, gawking at the giant Freudian extravaganza signs, unable to identify at all with the flashing lights and plastic. We got furious at the Brooks Rent-A-Car...oooooh, those scoundrels!

The Convention was nice. I got a chance to talk with a few old friends and sold a few subscriptions. Everybody there turned out to already be a subscriber.

On the way back to New Hampshire we stopped off at Aspen, Colorado for a little skiing. I do believe that they normally have the best skiing conditions in the world there at Buttermilk Mountain. Aspen is an old mining town and the prices are mining town prices. They have more top notch restaurants per capita there than any place else I know, so perhaps it is worth the price. We skiied all day, soothed our sore muscles in a sauna in the evening, ate luxurious dinners and had a wonderful time.

Back in New Hampshire we found the ski slopes worn to ice and dirt patches, the inserting machine for renewal notices jamming, the furnace out, the plumbing frozen, the offset press on its last legs, and other normal catastrophies.

Your Club

The club code and theory classes probably need a lot more customers to keep busy. Where to get them? The obvious place is the local high school. You can interest fellows in joining the club and learning about amateur radio by inviting them to come to your club meetings. Have one of your club members in the school put meeting notices on the school bulletin board asking all interested to come out to a club meeting and learn more about amateur radio. And don't forget to offer refreshments.

Not all CB'ers are bad people and you might do well to get the club members who have CB rigs to check the channels for good prospects to come to club meetings.

Once you have interested newcomers in coming to your club meetings you must do all you can to make them welcome and make arrangements for them to quickly get to know more about our hobby. Have members with good stations invite them over for a demonstration. Show them some phone DX work, some VHF, and perhaps some RTTY. Let them see some of the gadgets that your members have built.

Once your club gets into the swing of interesting new blood into our hobby, more and more ways will develop for getting interest stirred up. Pass along the ideas through the pages of 73 so everyone can benefit.

.....W2NSD/1

Rules for the 1969 I.A.R.C. Propagation Research Competition

(A DX Contest with a Purpose)

CONTEST PERIODS: This year the contest will be run in two sections. CW/RTTY from 0001 GMT 01 March to 2400 GMT 16 March. Phone from 0001 GMT 29 March to 2400 GMT 13 April.

OBJECTIVE: Work as many stations in as many different CPR Zones as possible. Countries do not count. Work your own Zone only once for Zone credit.

BANDS: All bands, 1.7 through 30 MHz.

EXCHANGE: RS or RST report plus your CPR Zone number.

DUPLICATE QSO'S: You may work the same station as often and for as long as you wish. When a single QSO exceeds 6 minutes a new log entry shall be made for each 6 minutes or part thereof.

LOGGING: Use GMT only. QSO's may be made with stations not in the contest if all necessary information is logged.

SCORING: 1 point for each QSO except in your own Zone. Multiplier 1 for each Zone on each band, including your own Zone. Total score is the sum of all contacts multiplied by the total Zones for all bands.

CLASSES: Single operator–single band; Single operator–all band; Multi-operator–all band; RTTY–all band; Mobile–all band; All events–all band.

AWARDS: Winners in each category will receive a suitable certificate or other award. All entries of 100 or more valid QSO's will receive a CPR Certificate.

Logs and summary sheets may be obtained from IARC, Box 6, 1211 Geneva 20, Switzerland, or from L' Rundlett, 2001 Eye NW, Washington DC 20006. Logs must be posted by 1 June 1969 to Mr. Rundlett.

Linear Systems Acquires SBE

Linear Systems, Inc., of Watsonville, California, well known in amateur radio for its' "Century" and "Commander" mobile power supplies, has recently acquired the SBE amateur transceiver line. The acquisition of SBE is in line with the company's objective of becoming a principal factor in the amateur market. An improved version of one of the foremost products in the line, the SB-34 transceiver, will be available in early 1969. Linear Systems intends to introduce other new transceivers, power supplies and accessories for the amateur market during the coming year, however the SB-34 will continue to be an important part of the line for a considerable time to come.

RAGS HAMFEST MARCH 29TH

The Radio Amateurs of Greater Syracuse annual hamfest will be Saturday, March 29th, at the Song Mountain Ski Center near Tully. 10AM 'till 9PM; flea market, contests, tech talks, snacks, plus buffet dinner and main speaker. Come and have fun!

Testing The Minilab

Since we, as amateurs, are supposed to be able to make reasonable repairs on our equipment by ourselves, it behooved us to have enough test equipment on hand to find out what has gone wrong when disaster strikes. This can lead to a whole workbench full of expensive gear if it gets out of hand.

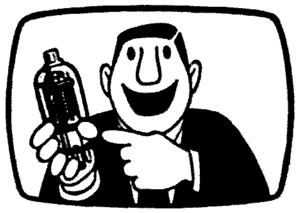
A recent ad in 73 for The Minilab seemed worthy of investigation. When our unit arrived for test we found that it was the usual VOM size, but that it had a printed circuit board and solid state circuits which made it not only a fine volt-ohmmeter, but also an rf field strength meter, an rf signal generator, an af signal generator and a substitution box for resistors and capacitors.

The af generator makes it possible to check out any audio circuit quickly, whether it be in a transistor radio, the transmitter speech equipment, a hi-fi amplifier or preamp, or a commercial sound system. The rf generator is tuned to 455 kHz and permits checking out the i-f system of most receivers. This oscillator can be retuned to 500 kHz if desired. This also is useful in providing a bfo injection for receivers which lack this function and will make even the little transistor short wave receivers capable of tuning in sideband signals or cw for you. The stability of some of these units can be something else though.

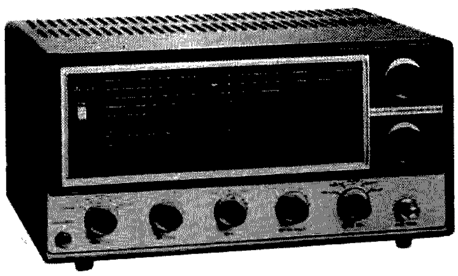
Once you think you've located a faulty part it is invaluable to be able to switch in a sample replacement to see if it makes the circuit work right. The Minilab has these substitution components built in.

Checking out a transmitter? Between the af generator and the rf field strength meter you can get a good idea of what is going on. There is a 9v battery output for testing transistor gear.

The Minilab is extremely well built. It uses a standard 9v transistor battery for powering the solid state circuits and two pencil light batteries for the ohmmeter function. The price of $25 seems quite reasonable for a package like this. Quite reasonable. Available from DGP, Box 431, Jaffrey, N.H. 03452.



NEW PRODUCTS

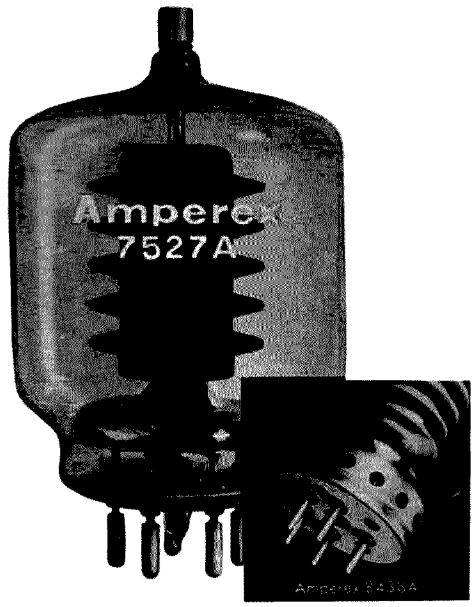


Allied Solid-State Receiver

This Allied Receiver, model A-2515, is designed for use by Short Wave listeners as Hams. The 5-Band AM/CW/SSB unit, featuring advanced solid-state circuitry, tunes all Amateur bands from 80 to 10 meters, international short wave, aircraft, marine and other short wave broadcasts and the standard AM broadcast band. Bands covered are 150-400 KHz, 500-1600 KHz, 1.6-4.8 MHz, 4.8-14.5 MHz and 10.5-30 MHz.

Of the 24 semiconductors in the circuit, two are Field Effect Transistors in the RF stage to provide exceptional sensitivity and low noise level. Four mechanical filters are used for sharp station separation; noise limiter and automatic volume control reduce noise, blasting and fading. Built-in variable BFO and Product Detector give clear reception of code and single sideband. Visual tuning is made easy with an illuminated S-meter. The illuminated slide-rule dial has calibrated band-spread for 80-10 meter Ham bands.

Other features are a push-pull audio stage with thermistor for low distortion, receiver muting connections and a headphone jack for private listening. Equipped with dual power supplies, 117VAC and 12 VDC, the receiver can be operated from house current, cars, boats, trailers and at camp sites. Price of the receiver is $99.95. A separate speaker is priced at $9.95. Allied Radio Corporation, 100 N. Western Ave., Chicago, Ill. 60680.



New 4-400A!

Amperex has stolen the lead on the industry with their new model of the popular 4-400A tube. There are two big improvements in this new tube. First is the new mesh cathode which is not only significantly stronger than the older cathodes, but eliminates noise caused by vibration and reduces hum to better than −60 dB. Second is the anode made out of graphite instead of sheet tantalum. The high thermal capacity of graphite virtually eliminates any possibility of damage to the tube due to temporary overload. Tantalum-sheet anodes are easily damaged by local overheating.

The glass base model of this tube is the 7527A and the metal shell base tube is the 8438A. Both have the Amperex sintered glass base for strength and better heat distributing characteristics. Write Amperex, Professional Tube Div., Hicksville, NY 11802 for complete data. Please mention 73.

K3QDD Receives Scholarship

Twenty-one amateur radio clubs in the Washington-Baltimore-Northern Virginia area have provided funds to the Foundation For Amateur Radio, Inc., for a $500 scholarship award. Richard Tavin, K3QDD, was awarded the John W. Gore Memorial Scholarship on the basis of his amateur radio activities and his high scholarship standing at MIT. Most laudable.

New Books

Semiconductors: From A to Z by Dahlen. Published by TAB at $4.95 paper and $7.95 cloth bound. 272 pages, over 300 illustrations. Here it is, theory and practical application of every known type of semiconductor, right on up through Integrated Circuits. Covers diodes, FET's, MOSFET's, tunnel diodes, varicaps, photo-FET's, light sensitive and emissive devices, unijunctions, field-effect diodes, SCR and zener diodes, etc. Written for the average ham rather than the engineer. TAB Books, Blue Ridge Summit, PA.

Handbook of Transistors, Semiconductors, Instruments and Microelectronics, Thomas. Published by Prentice-Hall, Englewood Cliffs NJ at $20 in cloth. This is more for the engineer, the circuit designer or the laboratory technician. It is a practical guide to semiconductor operation, formation, ratings, characteristics, circuitry and applications. If you work with semiconductors this book is important to you.

There are 62 specific symptoms of trouble in a TV set, 14 color, 44 monochrome, and 4 sound. The **TV Servicing Guidebook: Problems & Solutions**, by Art Margolis, published by TAB Books, Blue Ridge Summit, Pa., at $3.95 in paperback and $6.95 in hard cover, describes 30 separate trouble-shooting approaches which those 62 symptoms call for. Service TV sets quickly, eliminate waste motion, cut trouble-shooting time to the bone. This is a practical how-to-do-it book, lavishly illustrated. 176 pages and over 100 illustrations.

104 Ham Radio Projects for Novice & Technician by Bert Simon, W2UUN, published by TAB Books, Blue Ridge Summit, Pa., at $3.95 paperbound and $6.95 hardbound. These are, for the most part, relatively simple circuits that will not strain the junk box severely. There are projects for 80, 40, 15, 6 and 2 meters, as well as UHF projects for 220, 432 and 1296 MHz. There are antenna projects, audio circuits, CW, preamps, preselectors, converters, and plenty of accessories. If you like to build or even think you would like to build, then this book will keep you busy for a long time.

Transistor Circuit Guidebook

Bad luck? Thirteen headings and up to 21 circuits per heading hardly qualifies as bad luck. More likely it is good luck for the purchaser, since anybody purchasing this book should find interesting material in it.

The circuits are supplied as schematics with parts lists and accompanying text. Their complexity ranges from a simple "rf Booster" circuit to complete systems for radio reception, hi-fi or counting and control purposes. Many of the entries are based upon manufacturer's literature showing applications for recent solid-state products.

Very complete information is included with some of the circuits, but others will require a bit of research before construction. Many of the circuits appear instantly adaptable to new projects. Ideas may be generated by looking, for instance, at schematics for 50 and 100 watt transistor rf amplifiers, an FM tuner front end circuit which could be adapted to six or 2-meter operation, an IC IF amplifier, or a common-base dip oscillator.

The intergrated-circuits application schematics (there are several of these) include a remote-control system, a low-noise amplifier, and three counter circuits. A decimal counter uses four bistables and ten NOR gates, but some ingenuity or careful reading may be needed to choose the appropriate IC's for this one.

A total of 104 circuits are presented in this handy 224 page book. Tab' #470 Transistor Circuit Guidebook is available at your dealer's or from TAB Books, Blue Ridge Summit, Pa. 17214. Price is $6.95 hardbound or $4.95 in paperback.

Electronic Circuit Design

Modern Electronic Circuit Design, by James D. Long. 284 pages; 170 illustrations. McGraw-Hill, $12.50.

Something very interesting is happening in electronics. The business is getting very complicated, and so is the hobby, but modern writers are finding better ways to present the subject. One change appearing in recent years is the development of approaches to the subject that are intermediate in diffi-

culty between the no-math elementary approach (almost useless to anybody working at a level above that of wire-man) and the thorough-going network- and systems-analysis engineering approach.

Here is an example of this trend. The first real-circuit problem appears on page 3, and after two additional chapters of introductory material your attention is brought to one of the most basic facts of practical design: the behavior of real components. How are they different from their ideal counterparts? In many ways: parasitic properties, humidity effects, ageing, for instance. One valuable but not very obvious example is the difference between tolerance and stability of a capacitor.

Later chapters deal with equivalent circuits, transistor limitations, operating-point stabilization (a vitally important matter, if the circuit is to be reliable), and finally amplifiers and switching circuits.

Long's approach requires less math than good technicians are expected to understand, and the book contains many worked problems chosen to resemble real design problems. If you are feeling frustrated by experiences with circuits you've picked out of a book, or would like to work up something that's really your own development (and this is easier than you may believe) this book deserves your attention.

Test Instrument Projects

101 *Easy est Instrument Projects,* by R. Brown & W. Kneitel. From H. W. Sams & Co., 1968. $3.95 in paperback.

If you are interested in simple test instrument projects, here are a hundred and one suggestions complete with three handy substitution and color code tables.

Their complexity ranges from a simple battery-and-lamp continuity tester or a very basic signal tracer circuit through a more elaborate transistor checker and some power supplies to a metal locator, several test oscillators, and frequency calibrator circuits.

The projects listed in this book really are easy. All are simple, and additional data provided by the authors includes some hints and suggestions on parts substitutions.

FM Receivers

Frequency Modulation Receivers, by A. B. Cook and A. A. Liff. Prentice-Hall Inc., 1968.

This 527 page book is a thoroughgoing discussion of wide-band FM circuit technology. It is based upon an unusually small math background, not including any calculus, which will make it accessible to many radio amateurs and to service workers interested in this key part of the commercial electronics field. Wideband FM is a very effective system for conveying speech and similar signals, and after looking at this book I begin to see some of the reasons for its good reputation.

Most of these appear in the first three chapters of the book. These are, respectively, "Introduction," "Interference," and "Noise." Following this opening the writers proceed to discuss, one part at a time, the basic circuit sections common to all FM receivers (good designs are invariably superhets, but there is some variety of FM detector circuits). The last three chapters deal with tuning indicators, some miscellaneous topics, and with stereophonic broadcasting. Coverage of all topics is quite complete.

If you are interested in wideband FM for communications purposes, as a hobby, or if it plays a part in your career, this book certainly deserves your interest.

Bench-Tested Communications Projects

What is the difference between a bench-tested communications project and another project that is not bench-tested? Maybe it is in the excellent photography, or perhaps in this book's good choice of subjects that are interesting, useful and not too hard to build. That is a rather hard mix to achieve, in real life.

The book is broken into four general sections: Experimenters' Delights, a set of six assorted circuits of general interest; Communications Capers, several projects interesting to hams and to CB'ers; Better Listening six circuits useful to anybody who is listening on the ham or shortwave bands, and Workbench Wonders, three test circuits and some good suggestions on using subassembly construction when making up new gear.

All the circuits described in this book have been published previously, and its editor, Julian Sienkiewicz of Radio-TV Experi-

menter and Elementary Electronics, has personally worked with them. This complete collection of construction articles is available from the Hayden Book Co., Inc., 116 West Fourteenth St., New York, N.Y. 10011 and is very reasonably priced at $3.25. Ask for their book #0788, *Bench-Tested Communications Projects.*

Data Book

Data Book for Electronic Technicians and Engineers, by John Lenk. From Prentice-Hall, $7.25.

If you are working in electronics, or have more than a passing interest in designing and building your own circuits, you might examine a copy of this book. Its writer has tried to sort out from all the thousands of possibly interesting or useful facts, charts, tables, and equations, the ones that are basic or specially interesting. He doesn't claim to meet all requirements, but has tried to supply a generally useful collection. I would say he has succeeded.

Chapter 1 is a review of the appropriate mathematics. It is not difficult mathematics, and the pages are not cramped full of tightly packed little bits of information. Following this are sections on passive circuits, and the components used in passive circuits. One chapter goes to AC concepts, another to antenna and transmission line data. Vacuum tubes are covered well, but transistors are hardly mentioned. There is a large appendix of tables, symbols, and some math functions.

Placing equations and other data very close to diagrams representing the system described is a nice idea that could get more frequent application. There is an unusual amount of explanatory text in this book, and that is a successful variation, too from some common practice.

The book is oriented to the needs of communications, rather than of industrial or control type circuit workers.

Modern Electronic Troubleshooting

Would you like a really complete book on troubleshooting electronic circuits? A book which is written to be used? Probably most technicians and engineers who are working with electronics gear could use a look at this remarkably thorough book which manages to convey a lot of basically useful information without getting very theoretical. It starts with some ideas about checking diodes and transistors, spends a chapter on printed circuits, another on capacitors, and then goes into more general material.

This includes TV circuits, of course, and transistor radios. Two-way mobile gear is well covered, too. Certain types of problems receive special attention, and the entire text is scope-oriented simply because the oscilloscope is an indispensable tool for any serious serviceman. Since not all workers can invest large sums in the modern triggered sweep scopes, one chapter describes the installation of a transistor circuit for conversion of any inexpensive repetitive-sweep scope to a triggered-sweep instrument. There are chapters on other items of test gear, as well, adding up to 23 chapters in all. The illustrations are very good.

The price is $4.95 in paper but serious workers will probably prefer the $7.95 hardcover edition, which will stand more use. This book is a Best Buy, ask for their book #474, *Modern Electronic Troubleshooting,* from TAB Books, Blue Ridge Summit, Pa. 17214. But before you send for it, check your local distributor's shelves.

Modern TV Waveform Analysis

Should you be interested in TV servicing? Yes, and there are two good reasons. If there is any clear example of a complex technology appearing in people's homes, it is TV circuits. Those who feel TV programming is deficient in value must agree the technology that brings it into the living room is a remarkable achievement.

And another reason is that many amateurs are becoming interested in TV and TV-type transmissions. A study of the appropriate theory, even a careful and complete study, cannot develop the familiarity that comes when you try to understand what happens when the circuits do *not* work. This

is the acid test. It sorts out the fellows who read one book so many times it's engraved on the skull, from those who look around more generally and find out how the circuits work.

One good book for the serious TG worker is *Modern TV Circuit & Waveform Analysis,* by Stan Prentiss. Stan's key idea is, what do you see if you look at the circuit with a good scope? Appropriate test gear is assumed throughout, which is a necessary assumption for the serious worker and a simplifying one for the man who is seeking a better background.

Chapter 1 discusses the basic waveforms and the circuits in which these waveforms are observed. Eight following chapters discuss the operation, adjustment and servicing of the basic circuit groups in TV sets. The color TV circuits should have received stronger emphasis in the Table of Contents since a quick glance could suggest the book does not treat this subject. Actually, it comes up in several chapters and Chapter 9, Chroma Circuits, is entirely devoted to this subject.

And Chapter 10 discusses troubleshooting solid-state circuits. It starts with notes on circuit design and continues to sections on locating defective parts and general troubleshooting procedures. Finally, several charts suggest approaches to common problems, and some schematics of solid-state TV sets are also included.

Ask for TAB book $476, *Modern TV Waveform Analysis,* at your local dealers' or from Tab Books, Blue Ridge Summit, Pa. 17214.

Hayden Books Catalog

Where do all the good books come from? If you have been surprised by seeing a specially valuable book on somebody else's shelf or offered by some distributor you do not visit very often, maybe you would like to find out more about what is available for your use. It could be very important, in fact, in today's highly competitive world. If you have a catalog, then you can discover what to ask for.

The Hayden Book Co's catalog carries entries in twenty-seven different categories, and 15 of these could be interesting to an advancement minded electronics worker. Mathematics and mechanical technology, radio operation, space technology, electronics, electronics servicing, and computer technology are only a few of the headings you might look under, depending upon your interests and business needs.

Each book listed in the catalog is described in the standard library style, and this is followed by a paragraph or more discussing the subject matter you will find in the book. In smaller print, there is a list of the chapters in the book. You can usually determine if the book will be useful to you, after a careful reading of this material.

There are two indexes at the back of the catalog. One is a listing of the books by title, and the other a listing by author. For instance, a book by Pullen is probably worth investigating, if you are interested in circuits. Looking on page 89, we find Hayden lists two of his books.

Ask for the Hayden Books Catalog, available from your dealer's or from Hayden Book Co., Inc.,

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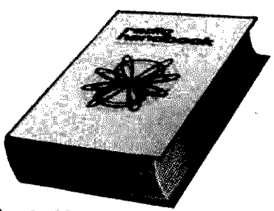

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So You Want to Be a Ham (4th Ed.)
by Robert Hertzberg, W2DJJ. Completely revised to include information on the incentive licensing. This is the book to have to learn about amateur radio, ham equipment, operating procedures, and how to pass the FCC exam. 192 pages. **20607,** *only*..................**$4.50**

ABC's of Ham Radio (3rd Ed.)
by Howard S. Pyle, W7OE. Enlarged and updated to include all the study material required to obtain the novice-class license. Covers latest FCC regulations, including new incentive licensing provisions. 144 pages.
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Amateur Radio Mobile Handbook
by Charles Caringella, W6NJV. Provides complete information for going mobile. Explains circuitry and construction of commercially built mobile amateur equipment. Shows how to build mobile converters, transmitters, transceivers, and modulators, etc. 176 pages.
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Technical Aid Group

Please refer any questions of a technical nature to one of the following members of 73's Technical Aid Group. These are dedicated amateurs who really want to be of help and do so without compensation. Be sure to state your problem clearly and enclose a S.A.S.E. for a reply.

John Allen, K1FWF, high school student, 51 Pine Plain Road, Wellesley, Mass. 02181. HF and VHF antennas, VHF transmitters and converters, AM, SSB, product data, and surplus.

Bert Littlehale, WA1FXS, 47 Cranston Drive, Groton, Conn. 06340. Novice transceivers, test equipment and homebrew projects gone wrong.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, New York 14619. Specializes in VHF/UHF solid-state power amplifiers, but will be glad to make comments on any subject.

G. H. Krauss, WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, New York 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitter and receivers, VHF antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Charles Marvin W8WEM, 3112 Lastmer Road, RFD #1, Rock Creek, Ohio 44084. Will help with any general amateur problems.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, New York 11360. Novice help.

Clyde Washburn K2SZC, 1170 Genesee Street, Building 3, Rochester, New York 14611, TV, AM, SSB, receivers, VHF converters semiconductors, test, general, product data.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, New York 11357. General.

J. J. Marold WB2TZK, OI Division, USS Mansfield DD278, FPO San Francisco, California 96601. General.

Ira Kavaler, WA2ZIR, BSEE, 671 East 78 Street, Brooklyn, New York 11236. SSB transmitting, color TV, computer programming and systems, digital, radio and remote control, rf transmission lines, dipole design, audio amplifiers, linear and class C rf amplifiers.

Fred Moore, W3WZU, broadcast engineer, 4357 Buckfield Terrace, Trevose, Pa. 19047. Novice transmitters and receivers, HF and VHF antennas, VHF converters, receivers, AM, SSB, semiconductors, mobile test equipment, general, product data, pulse techniques, radio astronomy, bio-medical electronics.

Walter Simciak, W4HXP, BSEE, 1307 Baltimore Drive, Orlando, Florida 32810. AM, SSB, Novice transmitters and receivers, VHF converters, receivers, semiconductors, mobile, test-equipment, general.

James Venable K4YZE MS, LLB, LLM, 119 Yancey Drive, Marietta, Georgia. AM, SSB, novice gear, VHF, semiconductors, and test equipment.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, Virginia 22042 General.

Wayne Malone W4SRR BSEE, 8624 Sylvan Drive, Melbourne, Florida 32901. General.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans, Louisiana 70118. Novice help and general questions.

Douglas Jensen, W5OG/K4DAD, BA/BS, 706 Hwy 3 South, League City, Texas 77573. Digital techniques, digital and linear IC's and their applications.

Louis Frenzel W5TOM, BAS, 4822 Woodmont, Houston, Texas 77045. Electronic keyers, digital electronics, IC's commercial equipment and modifications, novice problems, filters and selectivity, audio.

George Daughters WB6AIG, BS, MS, 1613 Notre Dame Drive, Mountain View, California. Semiconductors, VHF converters, test equipment, general.

Glen H. Chapin, W6GBL, 3701 Trieste Drive, Carlsbad, Calif. 92008. HF and VHF antennas, novice transmitters and receivers, VHF converters, semiconductors, receivers AM, SSB, general, surplus.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, California 91780. ATV, VHF converters, semiconductors, general questions.

Steve Diamond WB6UOV, college student, Post Office Box 1684, Oakland, California 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, VHF antennas and converters, receivers, semiconductors, and product data.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, California 95240. TV, HF antennas, SSB, VHF antennas and converters receivers, semiconductors, and general questions.

Hugh Wells, W6WTU, BA, MA 1411 18th Street, Manhattan Beach, Calif. 90266. AM FM receivers, mobile test equipment, surplus, amateur repeaters, general.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, Calif. 94952. Double sideband.

Howard Pyle W7OE, 3434—7th Avenue, S.E., Mercer Island, Washington 98040. Novice help.

PFC Grady Sexton Jr. RA11461755, WA1GTT/DL4, Hedmstedt Spt. Detachment, APO New York 09742. Help with current military gear, information from government Technical Manuals.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO New York 09665. Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

Eduardo Noguera M. HK1NL, EE. RE, Post Office Box Aereo 774, Barranquilla, Columbia, South America, Antennas, transmission lines, past experience in tropical radio communications and maintenance, HF antennas, AM, transmitters and receivers, VHF antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

D. E. Hausman, VE3BUE, 54 Walter Street, Kitchener, Ontario, Canada. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Frank M. Dick WA9JWL, 921 Isabelle Dr., Anderson, Indiana 46013. Will answer queries on RTTY, HF antennas, VHF antennas, VHF converters, semiconductors, mobile, general, and microwave.

Gary De Palma, WA2GCV/9, P.O. Box 1205, Evanston, Ill., 60204. Help with AM, Novice transmitters and receivers, VHF converters, semiconductors, test equipment, digital techniques and all general ham questions.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, Pennsylvania 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

William G. Welsh W6DDB, 2814 Empire Ave., Burbank, Calif. 91504. Club licensing classes and Novice problems.

Ralph J. Irace, Jr., WA1GEK, 4 Fox Ridge Lane, Avon, Conn. 06001. Help with Novice transmitters and receivers and novice theory.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 S.W. Salmon St., Portland, Oregon 97205. This group of radio amateurs will answer any technical questions in the field of electronics.

Ted Cohen W4UMF, BS, MS, PhD. 6631 Wakefield Drive, Apt. 708, Alexandria, Va. 22307. Amateur TV, both conventional and slow scan.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, Illinois 61820. Antennas, transistors, general.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, Illinois 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, Wisconsin 53402. Novice transmitters and receivers, general.

John Perhay WAØDGW/WAØRVE, RR #4 Owatonna, Minnesota 55060. AM, SSB, novice transmitters and receivers, HF receivers, VHF converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

Ronald King K8OEY, Box 227, APO New York, New York 09240. AM, SSB, novice transmitters and receivers, HF receivers, RTTY, TV, test equipment, general.

Charlie Marnin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, Ohio 44084. General technical questions.

Michael Winter DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, Ohio 45342. HF antennas, AM, SSB, novice gear, semiconductors.

David D. Felt, WAØEYE, television engineer, 4406 Center Street, Omaha, Nebraska 68105. Integrated circuits, transistors. SCR's, audio and rf amplifiers, test equipment, television, AM, SSB, digital techniques, product data, surplus, general.

Tom Goez KØGFM, Hq Co USAMAC, Avionics Division, APO New York, New York 09028. HF antennas, mobile, airborne communications equipment, particularly Collins and Bendix gear, AM, FM, or SSB—HF, VHF, UHF, general.

Robert Scott, 3147 East Road, Grand Junction, Colorado 81501. Basic electronics, measurements. ■

MOVING?

Every day we get a handful of wrappers back from the post office with either a change of address on them or a note that the subscriber has moved and left no address. The magazines are thrown out and just the wrapper returned. Please don't expect us to send you another copy if you forget to let us know about your new address. And remember that in this day of the extra rapid computer it takes six weeks to make an address change instead of the few days it used to when we worked slowly and by hand.

Surplus Conversions

Hardly a week goes by without receiving many requests from readers asking where to find information regarding a particular piece of surplus gear they have picked up without a manual or any conversion information.

In addition to the following literature, *73's Index to Surplus* should give all the information as to where to find conversion for almost any surplus equipment. This handy reference is available from 73, Peterborough, N.H. 03458 for the modest sum of $1.50.

Editors and Engineers

Editors and Engineers, P.O. Box 68003, New Augusta, Indiana, have published three *Surplus Radio Conversion Manuals* by Evenson and Beach and the *Surplus Handbook, Vol. I* by W6NJV and W6NJE. Each costs $3. Here are the pieces of equipment covered in each manual:

Surplus Radio Conversion Manual, Vol. I. BC-221, BC-342, BC-312, BC-348, BC-412, BC-645, BC-646, SCR-274 (BC-453A and BC-457A series), SCR-522, TBY, PE-103A, BC-1068A/1161A.

Surplus Radio Conversion Manual, Vol. II. BC-454, AN/APS-13, BC-457, ARC-5, GO-9/TBW, BC-946B, BC-375, LM, TA-12B, AN/ART-13, AVT-112A, AM-26/AIC, ARB.

Surplus Radio Conversion Manual, Vol. III APN-1, APN-4, ARC-4, ARC-5, ART-13, BC-191, BC-312, BC-342, BC-348, BC-375, BC-442, BC-453, BC-455, BC-456-9, BC-603, BC-624, BC-696, BC-1066, BC-1253, CBY-5200, COL-43065, CRC-7, DM-34, DY-2, DY-8, FT-241A, MD-7/ARC-5, R-9/APN-4, R-28/ARC-5, RM-52-53, RT-19/ARC-4, RT-159, SCR-274N, SCR-508, SCR-522, SCR-528, SCR-538, T-15 to T-23/ARC-5, URC-4, WE701A.

Surplus Handbook, Vol. I. This book, subtitled, *Receivers and Transceivers*, is composed of schematics and pictures of the following gear. It doesn't give conversions. APN-1, APS-13, ARB, ARC-4, LF and VHF ARC-5, ARN-5, ARR-2, ASB-7, BC-222, BC-312, BC-314, BC-342, BC-344, BC-348, BC-603, BC-611, BC-624 (SCR-522), BC-652, BC-654, BC-659, BC-669, BC-683, BC-728, BC-745, BC-764, BC-779, BC-794, BC-923, BC-1000, BC-1004, BC-1066, BC-1206, BC-1306, BC-1335, BC-AR-231, CRC-7, DAK-3, GF-11, Mark II, MN-26, RAK-5, RAX, RAL-5, Super Pro, TBY, TCS, VT tube cross index.

CQ Handbook

CQ has two handbooks on surplus out. They can be ordered from CQ, 14 Vanderventer Avenue, Port Washington, N.Y. The first book, the *Surplus Schematics Handbook*, by Ken Grayson W2HDM, costs $2.50, and contains schematics and short comments about this gear: APA-38, APN-1, APR-1, APR-2, APS-13, ARB, ARC-1, ARC-3, ARC-4, ARC-5, ARC-5 VHF, ARJ-ARK-ATJ, ARN-7, ARR-2, ART-13, ASB, AS-81-GR, ATK, BC-AR-231, BC-189, BC-191, BC-221, BC-312, BC-314, BC-342, BC-344, BC-348, BC-375, BC-438, BC-474A, BC-603, BC-610, BC-611, BC-620, BC-640, BC-645, BC-652, BC-653, BC-659, BC-683, BC-684, BC-728, BC-733, BC-745, BC-779, BC-794, BC-906, BC-969, BC-1000, BC-1004, BC-1023, BC-1206, BC-1335, BN, BP, C3, CRC-7, CRO-208, CRT-3, DAE, F3, GF-11, GO-9, GRR-5, 1-122, 1-177, 1-208, JT-350A, LM, Mark II, MD-7, MN-26, PRC-6, PRS-3, R-174, RAK, RAL, RAO-7, RAS, RAX, RBH, RBL, RBM, RBS, RC-56, RC-57, RDC, RDR, RDZ, RU-16, SCR-274, SCR-284, SCR-288, SCR-300, SCR-506, SCR-522, SCR-578, SCR-585, SCR-593, SCR-608, SCR-610, SCR-624, SCR-628, SPR-1, SPR-2, TBS, TBW, TBX, TBY, TCK, TCS, TG-34, TS-34/AP, TS-251/UP, VRC, VVX-1.

The other CQ book, the *Surplus Conversion Handbook* by Tom Kneitel K3FLL, ($3) contains conversion on these pieces of gear: ARC-1, ARC-3, ARC-4, ARC-5, ARC-36, ARC-49, ART-13, ATA, ATC-1, BC-191F, BC-224, BC-312, BC-314, BC-343, BC-344, BC-348, BC-375E, BC-453, BC-454, BC-455, BC-457A, BC-458A, BC-459A, BC-603, BC-604, BC-620, BC-624A, BC-625A, BC-659, BC-669, BC-683, BC-684, BC-696A, BC-779, BC-794, BC-946, BC-1004, BC-1068A, CBY-52232, PE-73, PE-103, R-129/U, RAX-1, SCR-177, SCR-188, SCR-193, SCR-274N, SCR-399, SCR-499, SCR-508, SCR-509, SCR-510, SCR-522, SCR-528, SCR-542, SCR-608, SCR-609, SCR-628.

Getting Your Extra Class License

Part II — Amplifiers

Almost every stage of any radio equipment contains an amplifier circuit of some sort. Understandably, the Extra Class examination includes a number of questions designed to test your knowledge of amplifier theory and its application—and this month we're going to concentrate on them.

Specifically, the questions from the FCC study list which we're going to examine in detail this time are:

6. Why is there a practical limit to the number of stages that can be cascaded to amplify a signal?

42. List Several advantages and disadvantages each for Class A, Class B, and Class C amplifier operation.

66. How are grounded-grid amplifiers used in electronic circuits? List some advantages and disadvantages of their use.

73. What improper operating conditions are indicated by the upward or downward fluctuation of a Class A amplifier's plate current when a signal voltage is applied to the grid? How can this be corrected?

74. What improper operating conditions are indicated by grid current flow in a Class A amplifier?

As usual, rather than approaching these official study questions directly, we'll paraphrase them into several other questions of broader scope, in order to better cover the subject.

The most basic of all questions that can be asked about amplifiers is "How Does An Amplifier Amplify?"—so let's ask it as a starting point. From there, we'll try to learn "Where Can An Amplifier Be Grounded?", which should take care of all the various grounding methods for signal inputs and outputs. Our third question will be "What Limits An Amplifier's Usefulness?", and we'll follow this up with a natural sequel, "How Can The Limits Be Stretched?"

By the time we find the answers to these four questions, we may not be amplifier experts but we should certainly be able to handle any questions on amplifiers which may be on the Extra Class exam, as well as many which probably won't be there. Ready? Let's get started.

How Does An Amplifier Amplify? Before we can begin to find out how an amplifier amplifies, we must decide "What is amplification?" The answer may turn out to be a bit surprising.

To "amplify" is to make larger or stronger —but even though a transformer may make an ac voltage larger than it was originally, a transformer is not an amplifier.

As it happens, in electronics to "amplify" always means "to add power". While the ordinary transformer may step up either voltage or current, it cannot add power to the signal. Even a perfect transformer can only put out the same amount of power that is fed into it. If the voltage is doubled, the current must be cut in half to meet this power requirement. Similarly, if the current is doubled, it can only be done by cutting the voltage in half. And no transformer is perfect. The best transformers still have at least some losses. This means that in any practical transformer, the power output is always *less* than that put in, never greater. This is why a transformer is not considered to be an amplifier.

Any amplifier, though, does add power to the signal. The gain may appear as a voltage gain—output voltage greater than input voltage—or as a current gain, or as both at the same time, but the output power always is greater than the input power in the amplifying device itself.

Some amplifier circuits are arranged in such a manner that the power gain is somewhat hidden. In some cases this is deliberate,

to accomplish the purpose for which the circuit is designed, and in others it's merely incidental. In all of them, though, the actual amplifying portion of the circuit must involve a power gain.

One of the most common amplifier circuits in which the power gain is "hidden" is that type of circuit generally known as a "voltage" amplifier. Since audio amplifiers are usually divided into two classes called "voltage" and "power" amplifiers, respectively, there's a strong implication that there's no power amplification in the voltage amplifier.

While it's true that most voltage amplifiers take *almost* no power from their input sources, they *do* take at least a little. The input power may be as small as a thousandth of a microwatt, but it's greater than zero. The output power, similarly, is there; if the circuit produces a 40-volt peak-to-peak output signal with a ½-milliamp plate current swing, this amounts to about 700 microwatts RMS power. It's not much—and this is why the circuits are called "voltage" amplifiers—but it's there.

And if our example amplifier takes a 1/1000 microwatt input signal up to a 700-microwatt output level, it must have a power gain of 700,000 times. This would be a fantastic figure; the power gain of most voltage amplifiers lies between 100 and 1000 times.

The so-called "voltage" amplifier, then, is just as much an amplifier of power as is the "power" amplifier, but its absolute power output is much much smaller. The power output of a voltage amplifier is useful only insofar as it produces the desired gain in voltage.

Now let's see how an amplifier goes about its business of adding power to a signal.

A moment's thought will reveal that we've already listed several necessities for amplification to occur: we must have an input signal, and a source of power which can be added. Also, we must have some means of getting the amplified output signal out of the circuit.

That's almost the complete list; only one more item is needed. That's a device which can "transfuse" power from the power source into the signal.

The devices we have to do this job don't do it in just that manner. Instead, they use the power of the input signal to *control* the flow of power from the source through the output circuit. It works out to be the same, however.

Two such devices, basically, are all we have with which to amplify ac signals. They are the vacuum tube and the transistor. Both act as electrically-controlled variable resistors, controlling the flow of current through themselves and thus through the output circuit.

The tube's plate current is controlled by the *voltage* on the grid, while the current in the collector circuit of the transistor is controlled by the *current* injected into (or withdrawn from) the base. In either case, the result of applying an input signal is to cause a variation of current flow in the output circuit. This current flow may be used directly, if current amplification is desired, or it may be converted to a voltage variation by a suitable load impedance.

The amount of control over output-circuit current flow which any particular tube or transistor's input signal can have is determined mainly by the geometry of the innards of the tube or transistor. This is the problem solved by the designer of that particular type of tube or transistor. Within certain physical limits, the designer can produce just about any combination of control effects you might want. For some purposes one combination is best, while for other jobs a completely different set of effects is necessary. That's one of the reasons why there are so many different types of tubes and transistors on the market.

When the designer has done his job, and the device is built to accomplish the desired control effects, the results are generally displayed in the form of "characteristic curves" which plot output signal against input signal. Many types of such curves are available; for our purposes we'll concentrate on the grid-voltage/plate-current family such as that shown in **Fig. 1.** This type of curve plots plate current against grid voltage; while **Fig. 1** shows only a single curve, any actual set of curves will have many, because a single tube type has a different curve for each different value of plate voltage which you might apply to it. Transistors have similar curves, not shown here.

Fig. 1 also shows how the electrically-controlled variable resistor called a "tube" is l'mited by some physical facts. At I in the figure is shown an "ideal" E_g-I_p plot for a perfect resistor. The output current depends

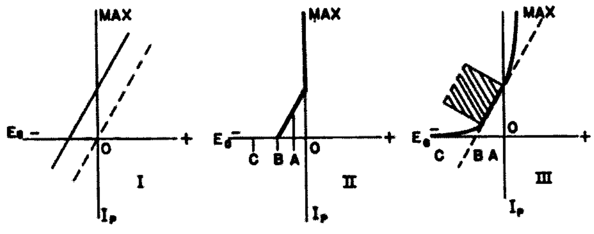

Fig. 1—Characteristics of vacuum tubes are often shown by curves which plot plate current (vertical scale) against grid voltage (horizontal). A completely linear device would produce a plot such as that at I—and the dotted line in this plot is actually the characteristic of a resistor; as voltage goes up, so does current, in a linear manner. Tubes, however, cannot operate with "less than zero" plate current, and when the grid goes positive it acts more like another plate than it does a grid, so the plot shown at II is the best that could be expected from a perfect tube. Actual tubes are less than perfect; their characteristic is curved rather than straight, and looks more like the plot at III. The shaded area in III identifies that part of the curve which is straight enough to act as if it were a straight line—normally called "the linear region" of the tube's characteristic.

only upon the input voltage, and there's no limit on the input voltage in either direction.

However, in a tube, when you've cut the plate current all the way to zero you cannot cut it down any more because there just isn't any more left to cut. This imposes a lower limit on the variable-resistance action. And when you drive the grid voltage positive, the grid then begins to act more like a second plate than it does like a grid, so you lose control at the other end as well. Part II of **Fig. 1** shows this idealized E_g-I_p plot for an actual vacuum tube.

Finally, since the actual control effects are determined by the geometry of the tube's insides, there are no sharp breaks or corners in the effects. Rather, they blend smoothly from one type of action into another. And in fact, the actual performance curve is *never* a straight line as long as current is flowing. It always curves at least slightly. This is shown as part III of **Fig. 1**.

To get perfect amplification, the curve would have to be straight as in the slanted portion of part II. Fortunately, most tubes have a fairly wide region in which the curve is almost straight—so much so that we can ignore the slight curvature—and this is indicated by the shaded region in Part III. For "distortion-free" amplification, we must be certain that we restrict all operation to this part of the curve.

As it happens, not all amplification must be "distortion-free". When we're generating *rf* for use as either an AM carrier or for CW, for example, the only things we're interested in are frequency and power level. If the level should happen to vary at the input to an amplifier, we not only are uninterested in preserving the variation unchanged at the output, but actually want the variation to be washed off by the amplifier so that the output level is steady.

In other cases, we want to preserve the variations in level of the input signal, but we may want more power output than we can get by restricting amplifier operation to the linear region of the tube's curve. If we have some means for taking out the distortion which results from overdriving, we can get the additional power.

These varying requirements which amplifiers are called upon to meet result in the existence of several different "classes" of amplifier operation. They're known as Class A, Class B, and Class C, and in addition to these three classes there's a fourth called "Class AB" which covers the entire range of operating conditions between Class A and Class B.

The definitions of the various classes have become somewhat confused through the years. The "official" definitions set up many years ago by the Institute of Radio Engineers (now a part of the IEEE) are as follows:

"A Class A amplifier is an amplifier in which the grid bias and alternating grid voltages are such that plate current in a specific tube flows at all times.

"A Class AB amplifier is an amplifier in which the grid bias and alternating grid voltages are such that plate current in a specific tube flows for appreciably more than half but less than the entire electrical cycle.

"A Class B amplifier is an amplifier in which the grid bias is approximately equal to the cutoff value so that the plate current is approximately zero when no exciting grid voltage is applied and so that plate current in a specific tube flows for approximately one half of each cycle when an alternating grid voltage is applied.

"A Class C amplifier is an amplifier in which the grid bias is appreciably greater than the cutoff value so that the plate current

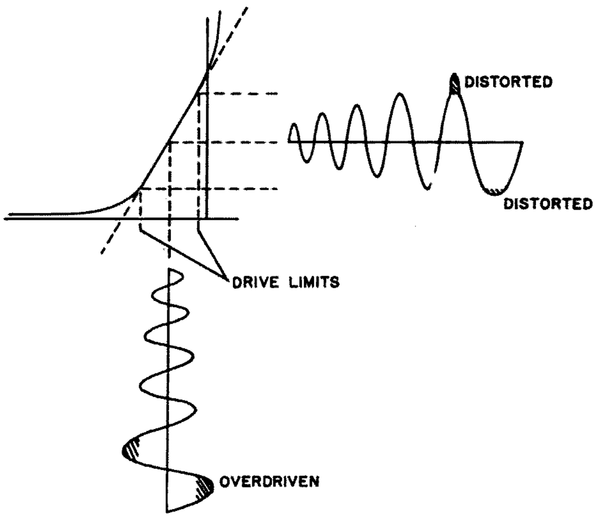

Fig. 2—A Class A amplifier is operated with a grid bias which makes the tube operate at the center of its linear region in the absence of signal. The signal voltage then varies the operating point, and thus controls the plate current. If the input signal exceeds the limits of the linear region, distortion results. The distortion is exaggerated in this illustration.

in each tube is zero when no alternating grid voltage is applied and so that plate current in a specific tube flows for appreciably less than one-half of each cycle when an alternating grid voltage is supplied."

Other definitions which have been offered specify a Class A amplifier as one in which the output is a faithful reproduction of the input signal. This is not, however, a requirement for true Class A operation even though most Class A amplifiers do have this characteristic.

Fig. 2 shows the action of a typical Class A amplifier, by plotting the variation of output current against the variation of input signal. Notice that the tube's characteristic curve furnishes the reference for making such a plot. For this reason, the E_g-I_p curve is often called the "transfer characteristic" of the tube. At any instant, the plate current is determined by the grid voltage. By plotting the variations in grid voltage (vertical waveform beneath the curve) and keeping the time scales constant, the variations in plate current may easily be determined (horizontal waveform to right of curve).

The zero-signal line which meets the tube's transfer characteristic curve in the center of its linear region marks the level of resting grid bias, and also the no-signal plate current which results from this value of bias.

The limits beyond which the input signal cannot be permitted to drive the amplifier are then determined by the points at which the tube's transfer characteristic begins to curve away from the straight line (dotted). If the signal pushes grid voltage past either of these limits as shown in the shaded regions of **Fig. 2**, the output signal will no longer be a faithful reproduction of the input signal—and distortion is the result.

The major advantage of the Class A amplifier is its freedom from distortion when properly operated. Additional characteristics which are sometimes considered advantages, and sometimes are disadvantages (depending upon the particular application) include its constant plate current. While the output signal is obtained only because the plate current varies, these variations occur as an audio rate; so far as dc instruments are concerned, the plate current remains constant with any level of input signal which may be applied. The variations cancel each other out.

The only way in which the indicated plate current can vary is for the dc bias point to change with application of signal. This occurs most frequently because of excessive input signal level. While excessive positive-going input signals may cause grid current to flow, it is not necessary to drive into the grid-current region to cause plate current to shift. Any change of plate current, either up or down, when signal is applied indicates excessive input-signal levels. The cure is simple—reduce the level of the input signal.

In many applications this constant plate current is an advantage, since it makes the amplifier present a constant load to the power supply circuits.

In other uses, the same quality is a disadvantage; for example, in a mobile or portable unit operating from batteries, it's wasteful to burn up power when no signal is being produced.

The major disadvantage of the Class A amplifier, however, is the low overall efficiency of the circuit. Most of the power supplied to a Class A amplifier is used to keep the tube at the chosen operating point. Even with a "perfect" transfer characteristic such as that in part II of **Fig. 1**, you would only be able to get output power over the region between cutoff and grid current. With practical amplifiers, the linear region is much smaller; thus the power output and

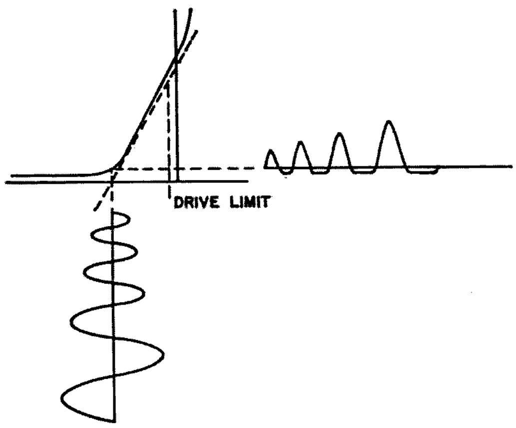

Fig. 3—Grid bias of a Class B amplifier is adjusted so that the tube has essentially zero plate current in the absence of signal. Positive-going half-cycles of the input signal then drive the operating point over to the linear region. Negative-going half-cycles are lost. The output signal is nighly distorted; in an RF Class B amplifier, only the modulation envelope is important and distortion of the individual RF cycles has no effect. In audio Class B circuits, push-pull arrangements are necessary to supply the missing half-cycles. Since the tube is passing no current half the time, it can handle considerably more power on the average.

total efficiency of the Class A amplifier are both kept relatively small. Plate current can swing only from zero up to the positive limit, and this swing must supply both halves of the output-signal cycle.

If, however, we change the grid bias to approximately the cutoff value for our tube, we convert our Class A amplifier into a Class B amplifier. This amplifier's operation is plotted in **Fig. 3.** Notice particularly that the *only* change we made was to move the grid bias level. The circuit itself remained unchanged. The differences between the various classes of amplifiers is entirely a matter of adjustment, not of circuitry!

With the resting grid bias at approximately the cutoff value, almost no plate current flows in the absence of input signal. When a signal is applied to the grid, the negative-going half-cycles of the signal merely bias the grid even farther into cutoff and stop all plate current, but the positive-going half-cycles move the tube's operating point up into the linear region.

As a result, the positive-going half-cycles are reproduced faithfully in the output signal, at the cost of the negative-going halves of the signal.

The output signal of a single-tube Class B amplifier is highly distorted, and such an amplifier cannot be used in this simplified version if faithful reproduction is what we're after.

However, if we simply add one more tube and feed it the same input signal—except in reversed phase—then the "positive" halves from one tube will fill in the gaps caused by the missing "negative" halves of the other, and our total amplifier will be relatively free of distortion. This is the push-pull circuit in its most natural form, and any Class B amplifier used for audio must be in a push-pull circuit to keep distortion within acceptable limits.

Additionally, tubes designed especially for Class B operation are preferable for such applications. These tubes are built to have the sharpest possible "knee" between the cutoff and linear regions ,to minimize "cross-over distortion" which occurs at the "cross-over points" between one tube and the other.

The Class B amplifier provides greater power from the same tubes than does Class A operation. Not only is twice the current swing available (Class A must get the whole cycle into the current swing between zero and maximum, while Class B need get only a half-cycle into the same current swing), but the fact that each tube is cut off and thus "resting" for half of each cycle permits us to pour more power into the circuit without damaging the tubes.

Where the overall efficiency of a Class A power amplifier lies between 25 and 30 percent in practice, with a theoretical limit of 50 percent, that of the Class B amplifier runs between 30 and 50 percent in practice and the theoretical limit is 86 percent.

This increased power is the primary advantage of Class B operation. A secondary advantage is the fact that most of the current drawn from the power supply goes into the output signal; no power is wasted keeping the tube at a fixed operating point. The variation in current with signal may sometimes be a disadvantage, though, since such an amplifier presents a varying load to its power supply, and the power source must then be capable of accomodating a wide range of load conditions.

The major disadvantage of Class B operation is the increased distortion and requirement for push-pull circuits. The push-pull requirement is not present in a Class B amplifier used for "linear" amplification of *rf*, since there we don't care about distor-

tion in the individual *rf* cycles. What we want to keep "linear" in such an amplifier is the modulation envelope of the signal, and the Class B amplifier preserves this nicely in its single-tube version.

A secondary disadvantage is the fact that a Class B amplifier requires more careful adjustment to obtain the proper operating point. Grid bias, especially, is extremely critical in this one.

The Class AB circuit was developed primarily to overcome these disadvantages of true Class B operation, and does so to a great degree—although the disadvantages do remain as the major ones of Class AB operation as well.

In a Class AB amplifier, bias is not so great as in Class B. Thus some plate current flows even with no signal. When signal is applied, the positive-going portions permit additional plate current flow just as in Class B operation, while the negative-going portions tend to cut plate current off completely. However in a push-pull Class AB amplifier (and almost ass AB amplifiers *are* operated in push-pull arrangements) the other tube supplies the missing half cycle.

The cross-over from one tube's operation to the other occurs at the resting value of plate current, though, which means that both tubes are in operation for very small signals and the first-one-then-the-other action applies only to the larger input signals. Because the transition from cut-off to the linear region of the tubes' transfer characteristic is gradual rather than abrupt, moving the crossover point to a higher plate-current value tends to reduce crossover distortion.

In the Class A amplifier, the main objective was to accomplish "linear" amplification without distortion. In both the Class B and the AB amplifiers, the idea was still to amplify without distortion, but circuit tricks were necessary in order to get rid of the distortion introduced by AB or B operation.

The Class C amplifier, on the other hand, is intended to distort its input signal. That is, its purpose is to put out the largest practical amount of power while washing off all variations of signal level which may be present in its input.

To do this, the tube's operating point must be changed rather radically. Instead of operating at the center of the linear region, as in Class A; at cutoff, as in Class B; or somewhere between, as in Class AB, the Class C amplifier is adjusted to an operating point far below the cutoff region. Thus no plate current can flow in the absence of an input signal. This is true of a Class B amplifier also, but with Class C because of the much greater bias the plate current remains zero even *after* input signal is applied, until the input signal goes sufficiently positive to overcome the added bias.

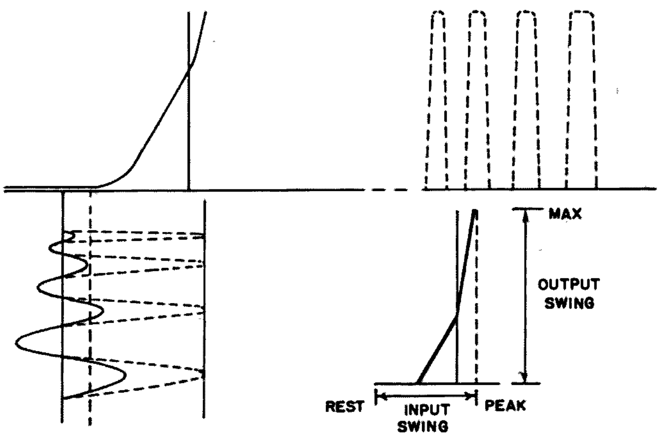

Fig. 4—Class C amplifier is biassed far beyond cutoff, so that tube acts more like a switch than a resistance. Only extreme positive peaks of input signal permit current to flow through tube. Signal is totally distorted; this type of amplifier is used only when amplitude distortion is unimportant. Since tube is resting most of the time, this class of circuit permits maximum power from the tube. Efficiency up to 80 percent is not uncommon. Idealized curve, inset, shows how circuit's characteristic resembles switch more than normal amplifier.

Fig. 4 shows the operation. With a normal-level input signal (solid waveforms) only the extreme tips of the positive half-cycles overcome the additional bias, and the output signal consists only of brief current pulses.

But Class C amplifiers are used primarily for *power* amplification of *rf* signals, rather than as voltage amplifiers, and in this application are driven with signals so large that they would be excessively strong signals to the other classes of amplifiers. Such an input signal and its corresponding output are shown in dotted lines in **Fig. 4.**

Actually, in a Class C amplifier, the tube is being used more like an electronic *switch* than as a variable resistor. There's really no difference, if you keep in mind that an ordinary switch is actually a resistor with two values (one very high, in the billion-ohm region, and the other very low, meas-

ured in hundredths of an ohm). When you operate the switch, you choose one of the two values.

In the Class C amplifier, the very high value of grid bias establishes the extra-high-resistance or "off" condition of the switch-resistor represented by the tube. The "over-drive" level of the input signal establishes the low-resistance or "on" condition. And the transition between one condition and the other, which carries operation all the way through the linear region of the tube, is made very rapid by the sharp rise and fall of the signal waveform.

The inset illustration in **Fig. 4** brings out this characteristic of the Class C amplifier. For Class C use, the linear region of the tube's transfer characteristic is only a nuisance. Tubes designed primarily for Class C operation, as a consequence, may not behave very well if you attempt to use them as linear amplifiers.

The advantage of Class C operation is its efficiency. Theoretically, you can get as close to 100% efficiency as you like in a Class C circuit. In practice, 75 percent efficiency can be reasonably expected, and with a little care it's possible to stretch this to 85 percent or so (the remaining 15 percent of output power can be gotten, all right, but it's in the form of high-order harmonics of the input signal, and any attempt to *use* it will get you in trouble for excessive harmonic radiation!).

Because the tube is being used as a switch, virtually all the dc power taken from the power supply goes into the output signal. The only part lost in the tube is the voltage drop from plate to cathode, which usually is only 20 to 50 volts at most; the rest of the losses occur in the associated tuning circuit, and in the process of converting those switched current pulses back into a reasonably harmonic-free signal waveform.

An additional advantage is that the power output of a Class C amplifier is not affected by the input-signal level (so long as the input drive is enough to reach the maximum-output level), but *can* be controlled easily by controlling the applied plate voltage. This means that modulation can be applied to a Class C amplifier with ease.

The steady output level without regard to input level, after a certain input threshold is reached, provides still another advantage. A Class C amplifier can be used whenever a signal *limiter* is needed, so long as there's no need to retain any of the amplitude variations. FM receivers sometimes use one or two stages of Class C amplifiers in their *if* strips for just this purpose.

Disadvantages of Class C amplifiers vary depending upon the application. The most obvious is the extreme amplitude distortion of the input signal, which makes them impractical for use with signals which must be amplified linearly (such as SSB or low-level-modulated AM). The high harmonic content of the output, if too great efficiency is sought, is another potential disadvantage; it may be overcome by keeping grid bias as small as possible while retaining the desired operating conditions, and keeping "drive" (input signal level) as low as possible consistent with desired operation.

Where Can An Amplifier Be Grounded? In addition to the various "classes" of amplifier operation which we have just examined, and which depend upon adjustment rather than upon circuit changes, there are many different amplifier circuits.

Many of the differences in these various amplifier circuits have to do with the grounding of the amplifier. For instance, the "normal" amplifier arrangement—that is, the one most commonly encountered—operates with its cathode grounded.

The cathode is not always actually directly grounded (although it frequently *is*, especially in *rf* amplifiers), but it is used as the return point for both the input and output circuits.

But we also have grounded-grid amplifiers, and, strange as it may sound, a grounded-plate circuit. The grounded-plate circuit is more often called the "cathode follower".

These different types of grounding for the input and output signals lead to vastly different sets of operating characteristics for otherwise identical amplifiers. The answer to our question can be fully expressed only if we can learn *how* the different groundings make such vast changes in amplifier action.

Let's start by forgetting all about amplifiers, tubes, and the like for a moment and considering a simple "black box". This is one of the favorite phrases of modern engineers, and with good reason. Any circuit whatever can be considered as an opaque black box; all we need know about it is

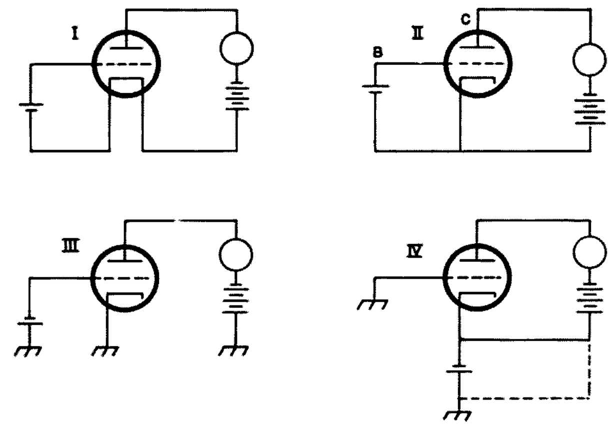

Fig. 5—Any amplifier circuit reduces to the basic arrangement shown at I; the separate input and output leads to the cathode are to emphasize the difference between input and output circuit. The version shown at II is electrically the same. It may be grounded at any of points A, B, or C, or even at other points not directly associated with a tube element. Most often, the cathode is grounded as shown at III; this permits both the input and output circuits to work "against ground". If the grid is grounded but the plate supply left ungrounded as shown by solid lines at IV, the circuit is not changed. Breaking the plate-supply return at X and connecting it as shown by the dotted lines does *change circuit action; text explains how and why.*

what its input and output terminals make it act like. What is actually inside couldn't concern us less, because in any practical application of theory, it's the results that count rather than how they got there!

The classical "black box" studied by engineers usually has four terminals; two of them are input, and the other two are for output. Any needed power supply is considered to be inside the box.

Any amplifier, you can see, can be thought of as such a box. We put a signal in at the input terminals, and we get out the amplified signal at the output.

Similarly, just a vacuum tube is also a "black box". We don't have to completely understand the electron physics involved, or the three-dimensional geometry which dictates the transfer characteristic, in order to make good use of the tube. All we need do is supply it the proper voltages, an input signal, and take off the output signal.

Right now let's ignore all the extra grids found in most modern tubes and think only of the classic triode with cathode, grid, and plate (the multi-grid tubes operate on the same general principles as the triode, anyway).

The electrons boil off the heated cathode and are drawn to the plate by the positive plate voltage. On the way, they must pass the grid; the voltage between grid and cathode controls the number of electrons which negotiate the path from cathode to plate.

Note that since we have only three elements in this tube, we cannot have four separate terminals on the black box model of it. Two of the four terminals *must* connect to the same element.

And the mechanics of tube action dictate that the cathode must be the doubled-up element, common to both input and output circuits. The controlling voltage is that between grid and cathode. The current controlled is that between cathode and plate. The control terminals, or input, then must be the grid and the cathode, while the controlled terminals, or output, must be the cathode and the plate.

So the tube is a three-terminal black box, rather than four. **Fig. 5** shows this schematically; part I shows the input and output circuits separately, using two leads to the cathode, while part II uses a common cathode lead.

Now so far as the tube is concerned—but only under some rather strict restrictions—it makes no difference at all which of these three terminals is connected to an external ground. In fact, all three could be kept ungrounded, and the tube would still do the same job.

But this is true only if both the input signal and the output signal are isolated from ground, both on the supply and the return sides of the circuit, and the power supplies also.

In any practical amplifier circuit, "ground" means much more than just a connection to chassis. "Ground" is the reference point for all circuits, and is used to shield from each other circuits which must be kept isolated.

And when "ground" is used in this way, then it does make a major difference whether the tube is grounded at point A or at point B.

When the cathode (point A) is grounded, as in part III of **Fig. 5**, then the input signal is applied between grid and cathode and the output signal is taken between plate and cathode. This corresponds to "normal"

action within the tube and so is the "normal" connection for an amplifier.

When we ground the grid instead (point B), as in part IV of the illustration, the first effect is that the phase of the input signal is effectively reversed because it is grounded on the opposite side of the circuit from "normal" connection.

If the isolated-output situation exists the circuit would be as shown by solid lines in part IV, and except for the phase reversal the circuit would behave exactly the same as that of part III. But the normal connection of output components and power supplies is as shown by dotted lines—and this puts the input and output circuits in series with each other.

This, in turn, means that all of the *output* amplified current must flow through the input circuit. Polarities are such that the input and output signals are in the same phase, so our grounded-grid circuit has 100 percent positive feedback. It's kept from oscillating by the fact that the feedback is *current* feedback while the tube amplified *voltage*. Still, the feedback results in much lower input impedance, and much higher output impedance, than we would find in a grounded-cathode circuit using the same tube in the same application.

The grid being connected directly to ground makes it an effective shield between plate and cathode, and this in turn permits operation of the tube at frequencies which otherwise would be too high to be practical for a given type of construction. It was this characteristic for which the grounded-grid amplifier was first developed, and is still one of the major uses of this type of circuit.

Since the input and output circuits are in series when the grid is grounded, any excess power in the input signal (above that necessary to drive the amplifier) passes on through to the output. This characteristic is taken advantage of in the SSB linear-amplifier circuits which employ grounded-grid stages; the low input impedance makes a good match to low-power transmitters used as exciters, and the power feed-through makes it unnecessary to swamp out excess input signal.

If the plate, rather than the grid, is grounded, then the input and output signals are effectively in parallel rather than in series. This prevents the output voltage from ever rising above the input voltage level, but allows current amplification.

In this case, the feedback is of voltage rather than current, but is negative rather than positive. The 100-percent feedback reduces distortion, and produces very low output impedance and high input impedance.

Cathode followers find wide use in preamplifiers and test instruments, to present a very high input impedance and reduce loading upon the circuits under test. They are also employed in conjunction with other amplifier circuits for special uses which we'll examine a little later.

While we've only examined tubes, transistor amplifiers follow the same general rules. **Fig. 6** tabulates the characteristics of the various types of grounding for both tube and transistor amplifiers.

Common ("Grounded") Element	Input/Output Ratios Voltage	Current	Impedances Out	In	E	—Gain— I	PWR
Vacuum Tubes							
Cathode (Normal)	>1	>1	Med	Med	Good	Good	High
Grid	>1	$\leqq 1$	Low	High	Good	None	Med
Plate (Cath. Foll)	$\leqq 1$	>1	High	Low	None	Good	Med
Transistors							
Emitter (Normal)	>1	>1	Med	Med	Good	Good	High
Base (Early CKTS)	>1	$\leqq 1$	Low	High	Good	None	Med
Collector (Emitter Follower)	$\leqq 1$	>1	High	Low	None	Good	Med

Fig. 6—General characteristics of the three different types of amplifier circuits are listed above for both tubes and transistors. Notice that circuit characteristics are determined by in/out ratios of voltage and current, more than by choice of tube or transistor. All comparisons assume that the same tube type or transistor type is used in the various circuits, of course. A low-gain tube with grounded cathode may have less gain than a high-gain tube in grounded-grid arrangement, still.

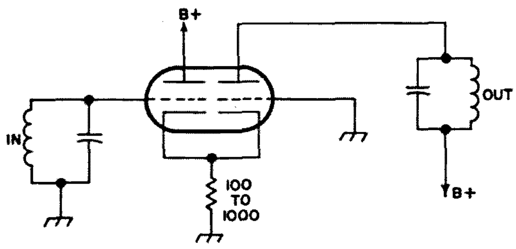

Fig. 7—Cathode-coupled amplifier consists of cathode follower stage (at left) direct-coupled to grounded-grid stage (right) with common cathode resistor. Almost any twin triode can be used; for RF use the TV-tuner types are recommended. Circuit can also be used for audio by using resistor-capacitor input and output coupling rather than the tuned circuits shown here. Circuit provides low noise of triode, gain equal to a single stage, and does not require neutralization.

What Limits An Amplifiers Usefulness? Amplifiers can be "cascaded", one after another, with the output signal of each furnishing the input signal to the next stage.

It might appear that any number of amplifier stages could be cascaded, to get any amount of gain we might want. This isn't the case, however. There are definite practical limits to the number of stages which we may cascade, and some good reasons for those limits.

The extreme limiting factor is "noise". Any substance at a temperature greater than absolute zero—which means anything at all that exists in the real world—has at least a few electrons in motion in it. They're jittering about because of the energy of heat, which is present in everything.

The exact number of electrons in motion at any instant, and their direction of motion, is totally unpredictable; it's something like trying to predict which kernel of corn is going to pop next in a corn-popper. Since we cannot predict it, the electrical energy which results from this random motion of electrons is called "noise"—and as we have seen, everything has at least some electrical noise present in it.

If we have several amplifiers, each with very high gain, and connect them in cascade with each other, we will quite rapidly reach a point at which the noise present in the input circuit of the first stage will provide all the output signal which the final stage can accept. Any input signal at all, under these conditions, would overdrive the cascaded amplifiers. Obviously, such an arrangement would not be usable.

In practice, we reach the limit much sooner. As soon as the amplified noise reaches an objectionable level in the output, we have all the amplification we can make use of. This condition is usually reached by the time we stack three or four stages in cascade with each other, if each stage has "normal" gain.

The noise also sets another limit—it determines the weakest input signal which we can locate. Any signal weaker than the noise cannot ever be made stronger than the noise, because any amplification which we apply to this signal will be applied to the noise as well.

This is the reason that we find so much emphasis on "low-noise" amplifiers for VHF reception and for high-quality audio work; they permit weaker signals to be used.

Any practical amplifier also has a limitation in the bandwidth it will handle. While we can build amplifiers to operate with dc signals, they're tricky; most amplifiers work only on ac, and use coupling capacitors to isolate the stages from each other so far as dc is concerned.

These coupling capacitors establish a lower limit on the amplifier's frequency range. When the reactance of the coupling capacitor is equal to the input impedance of the next stage, half the signal will be lost in voltage drop across the capacitor, and as a result the signal will get only half the amplification which a higher-frequency signal would get.

In addition, all practical amplifiers have stray capacitance in parallel with the input and output circuits.. This stray capacitance shunts off some of the output signal. So long as the reactance of the stray C is much higher than the impedances designed into the circuit, this has little effect—but as the signal frequency goes up the reactance of the stray C goes down, while the designed-in impedances tend to remain constant. This means that more of the signal is shunted off to ground, and again less output is obtained than we would expect.

The result is that any practical amplifier has a closely defined operating bandwidth. The low limit is set by the interstage coupling capacitors, and the upper limit by the impedances in the circuit and the amount of stray capacitance.

The bandwidth effect, also, is cumulative as stages are cascaded. At the low-frequency

end, if each stage is giving only half the amplification we would expect, then two stages would give ½ x ½ or ¼ the amplification we would expect, three stages would give only ⅛, and so forth. At the upper end, the same type of action occurs. The bandwidth of a multi-stage amplifier, then, is usually much less than that of any one of its stages.

This last statement is not always true. If all the stages except one are designed to cover a very wide bandwidth, while the one exception has narrow bandwidth, then the narrow-band stage will establish bandwidth for the entire amplifier. This situation is frequently encountered in hi-fi amplifiers, but seldom in radio applications.

How Can The Limits Be Stretched? The history of amplifier design is largely a history of successive, successful attempts to stretch the operating limits of existing amplifiers. Early vacuum-tube amplifiers had limited gain, narrow bandwidth, and were difficult to adjust. Today's circuits, while based on the same theoretical principles, can provide more gain than we can use, almost unlimited bandwidth, and virtual total freedom from adjustments.

The major limiting factors, as we have seen, are those of noise and of bandwidth. Another factor, which we didn't discuss previously because it is relatively unimportant with modern tubes and careful circuit layout, is that of unintentional feedback. The problem of unwanted feedback and techniques of neutralization were covered in the "feedback" installment of the Advanced Class course; they apply equally here.

The grounded-grid amplifier circuit employs the grid of the tube as a shield between input and output circuits to reduce the feedback problem—but it adds a new one of its own in the form of its abnormally low input impedance.

To counter this, the "cathode-coupled" amplifier circuit was developed. This circuit, shown schematically in **Fig. 7**, is essentially a cathode-follower to transform a high input impedance down to a low value without voltage gain, coupled directly to a grounded-grid stage. The grounded-grid stage provides voltage gain.

The cathode-coupled circuit works extremely well, and combats not only feedback but also the noise problem. Triode tubes inherently have less noise than do tetrodes

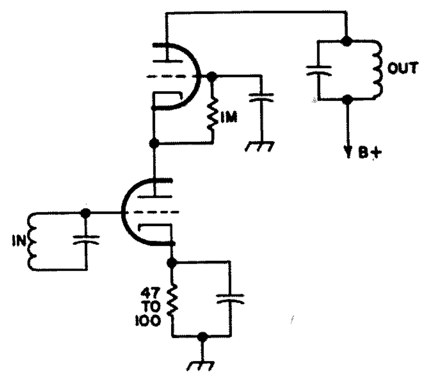

Fig. 8—Cascode circuit shown here replaced cathode-coupled arrangement in most applications, since gain is higher while noise is equally low when same tubes are used. Lowest noise is obtained if neutralization coil is added between plate of lower half and cathode of upper, but performance is usually adequate without coil as shown. While circuit is usually employed as RF amplifier, it also may be used at audio by changing input circuits accordingly.

and pentodes; each additional element introduces additional noise. The cathode-coupled circuit made it possible to use a twin triode in place of one pentode, and obtain approximately the same gain with far less noise.

A somewhat similar circuit, developed during World War II at the Radiation Laboratory of M.I.T. for radar use, surpassed the cathode-coupled amplifier in performance and rather rapidly supplanted it.

This circuit, shown in **Fig. 8,** is again a pair of direct-coupled amplifier stages with a grounded-grid output stage, but the input stage is a conventional grounded-cathode arrangement rather than a cathode follower.

The first stage is prevented from oscillating or being affected by feedback because its load is the low impedance of the grounded-grid circuit; the gain is too low for oscillation. However, even so the gain is greater than that of the cathode follower, and so the gain of the two tubes amounts to that which the two tubes would provide were both used as grounded-grid (or four used as cathode-coupled) stages.

The series circuit of **Fig. 8** is the final development stage; originally, shunt feed was used and the circuit was considerably more complicated.

This circuit, consisting of two tubes *cascaded* to produce the performance of a pent*ode*, was dubbed the "cascode" circuit

by its inventors, and is still widely used under that name.

While its main application is as a VHF *rf* amplifier, the cascode circuit is also sometimes used as an audio amplifier. Gain depends primarily upon the load seen by the second stage, and if the variant shown in **Fig. 9** is used as much as 2000-time voltage amplification may be obtained in a single cascode circuit. In this version, the added parallel resistor permits additional current flow through the "lower" tube section, keeping its gain high, while the extra-high valued load resistor of the "upper" section produces a wide voltage swing.

The problem of adequate bandwidth is attacked by many approaches. One of the most common is to use lower-than-normal load impedances; this reduces the effect of the unavoidable shunting stray capacitance and so extends the frequency limit of the amplifier upwards. As the load impedance is reduced, however, the gain per stage goes down accordingly and so more stages are required to get the same gain. Fortunately, the resulting narrowing of bandwidth because of added stages does not quite cancel out the improvement gained in the first place. It's not uncommon, though, to find eight to ten stages in a wide-band amplifier, providing about the same gain you would get from two or three narrow-band stages.

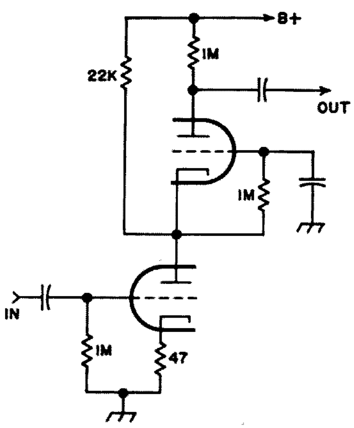

Fig. 9—This variant of the cascode circuit provides ultra-high gain, surpassing that normally obtained with pentodes. Extra-high load resistor in output circuit is responsible for high gain; 22K resistor shunting entire upper stage is necessary to provide adequate current for lower stage. Output impedance of this circuit is also very high and as a result high-frequency cutoff is usually rather low (below 3 kc). Third triode may be added as cathode follower to overcome part of this problem.

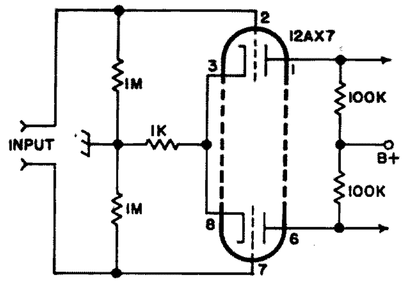

Fig. 10—Differential amplifier, often called simply "diff amp" in industry, is capable of DC amplification with relatively simple circuits. Circuit amplifies only the difference *between the input signals, and so cancels out any signal which appears on both input leads at same time in same polarity (such as hum or DC shift in power supply levels). Balance is maintained by common cathode resistor. Potentiometer may be added at junction of load resistors, with B+ applied to arm of pot, to permit static adjustment of balance as well.*

At the other end of the frequency limit the problem is somewhat different. As interstage coupling capacitors are made larger to permit improved low-frequency response, the amplifier's action in recovering from brief overloads gets progressively worse. The point is finally reached at which the amplifier requires several seconds to recover from a millisecond-long overload.

The coupling capacitors can simply be eliminated to provide response all the way down the frequency scale to, and including, dc. When this is done, though, any small change in power-supply voltages or tube characteristics is seen by all the following stages as a signal to be amplified. Because of this, a dc amplifier is much more tricky to keep operating properly.

One circuit widely used to overcome the instability problem of the dc amplifier is based on the idea that the two halves of a single tube change at about the same rate, and changes in power supply levels cannot hurt the signal if they are made to cancel themselves out. This circuit, the "differential" amplifier, is shown in **Fig. 10.**

In the differential amplifier, the signal to be amplified is applied, push-pull fashion, to the two grids. Each half of the amplifier stage operates essentially independently—but the output is not taken from plate to ground of either half. Instead, the *difference* in output levels between plates is used as the push-pull output signal.

Any change of power-supply levels affects both plates at the same time, and has little effect upon the *difference* signal. Similarly, any change of tube characteristics which affects both halves of the tube is also cancelled out.

By using the common cathode resistor, the cathode current of each half of the stage feeds back some of that half's signal to the other half. This improves the circuit's action greatly, because the feedback can occur only if *un*balance is present (if the amplifier is working as intended, the total cathode current remains constant—any increase in current in one half is offset by an equal decrease in the other half). Thus the desired difference signal is free of feedback, but any undesired components in that signal due to circuit unbalance are reduced by the feedback.

This self-balancing works so well that the circuit may be used to create the push-pull signal required, from a single-ended input. All you have to do is tie one grid to ground, and feed the desired signal to the other grid. The automatic balancing will put the proper input signal on the grounded-grid side, to produce the properly balanced push-pull output signal. Such a version is often found in hi-fi equipment, and also in sophisticated test equipment.

If the cathode resistor is returned to a negative supply of voltage approximately equal to the positive plate supply, several stages of differential amplifiers can be cascaded with all signal reference being to actual ground. This approach is almost a standard approach in lab oscilloscopes of the medium-performance class (top-grade instruments use different and much more complex amplifiers).

Next Month. VHF interest is consistently high; so are the problems of TVI. Since most TV broadcasting, and all ATV activity, is in the VHF region and above, we'll combine these subjects and explore them in our next installment. ■

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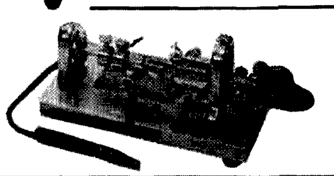

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April 1969
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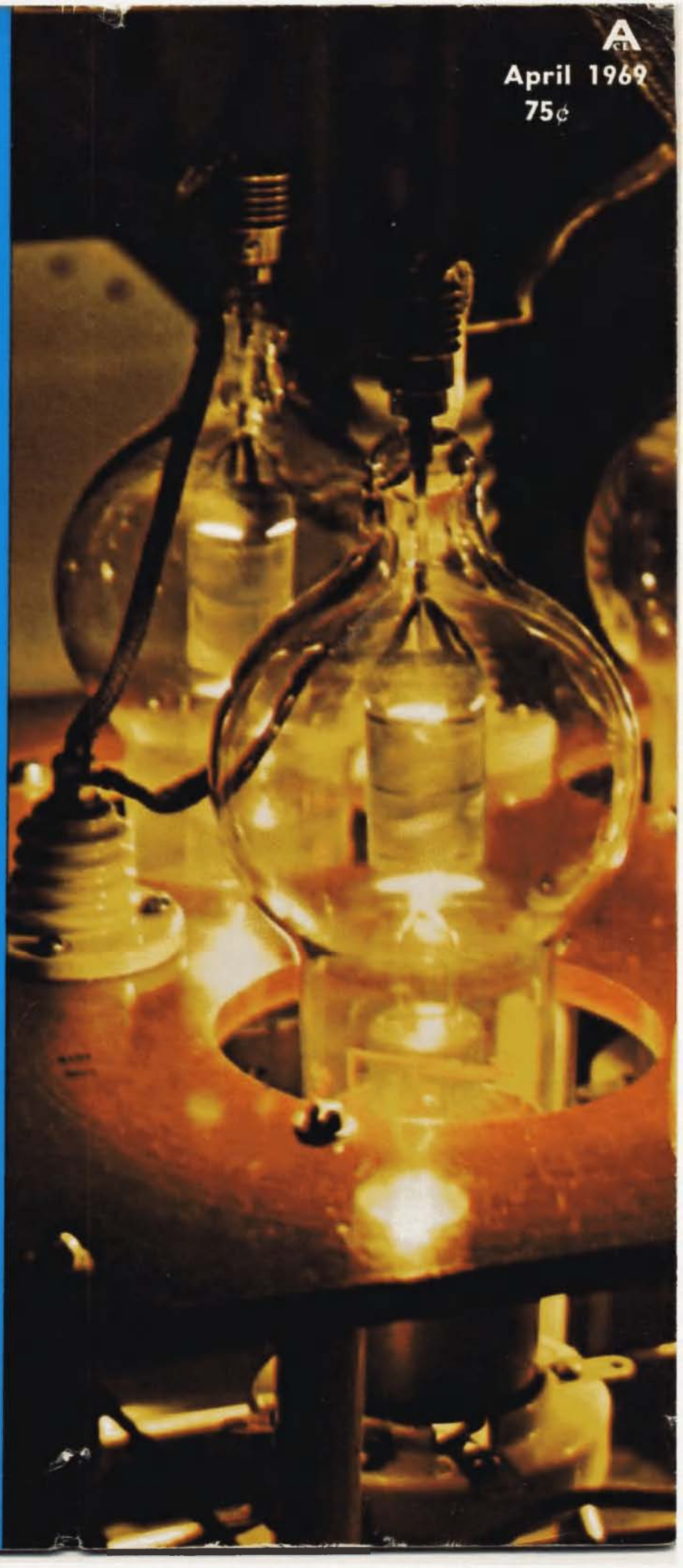

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73 MAGAZINE

April 1969
Vol. LXIX No. 4

Cover Photo: Power Supply for High Power Final Amplifier....K8TSQ.

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Wayne Green

With Kayla getting married and moving to Florida, I'll be back in the editor's chair after about four years of rest. I hate to see her go. Few hams know the good and the bad guys in ham radio as well as Kayla. We'll miss her perspective. Your letters were at first skeptical that a YL could turn out a good magazine in what is, essentially, a man's hobby. Once she got out from underneath the problems left by her predecessor the letters turned to raves.

In the last four years, 73 has been growing healthily. Our circulation just about doubled during the period while the circulation of the other ham magazines dwindled. Our basic format of concentrating on articles and more articles rather than filling up the magazine with low-cost monthly columns and contest reports seems successful. Our editorial policy of telling just what is really going on and how we feel about it seems popular with just about everyone except our fellow publishers.

From a one-man editorial staff we have grown to a whole team and are now setting all of the type for both the articles and ads in 73 in our typesetting department. Our art department has a number of illustrators preparing our schematics. Our production department is turning out not only 73, but is working on a whole line of new books. The Coax Handbook is the first of these and the Advanced Class Study Course is the second.

Our advertising department, headed by Bill Beatty, is doing quite well, but even so, Bill could use a little help from you. If you prefer to read a magazine that is made up of articles rather than columns and reports, then you should let the manufacturers and distributors who advertise in the ham magazines know where you are looking for their ads. If we had 50 pages of ads we could bring you a 200 page magazine every month with about 150 of them devoted to articles. If you'll look back you'll find that the last 200 page issue of QST had 68 pages of ads and only 34 pages of articles! The rest was activity reports and columns. You can vote for the magazine of your choice by letting the advertisers know where you want to see their new products and specials.

The articles in 73 will start to reflect my own interests again...VHF, DX, RTTY, FAX, contests, and a multitude of construction projects. I have some fabulous goodies in store for you. We'll emphasize antennas in May, VHF in June, mobile in July, transistors in August, transmitters and linears in September, receivers in October and transceivers in November. Our policy of paying the fastest and the mostest for good articles is giving us the pick of the articles and I could easily fill a 200 page magazine every month for you if you could just get the advertisers to back us up.

We are by far the most particular about who our advertisers are and if we get many complaints we bounce 'em until things are straightened out again. Some of the advertisers that are not in 73 are not in there because we will not accept their ads. You can get a good clue to this by checking for some that we have dropped in the last year or so. The readers of another magazine, one which brags about checking their advertisers, lost thousands of dollars to a crooked outfit from which we refused to accept advertising.

73 has grown beyond anything that I expected. Perhaps it is getting too big for me. Sometimes I wonder if we should go public and issue stock. Or perhaps we would do better to join one of the larger publishing houses and let them handle the business end of things. When a business gets this big there isn't enough time left for hamming. I miss that most of all.

It would be nice to be able to get away for a long trip to some relatively remote part of the world and DX a bit. We have all too few amateur DX-peditions. I see that Gus is off again, but Gus is a professional DXer and you have to pay him for working him, one way or another, or else he won't go. This was one of the big difficulties with Don Miller. I don't put much store in the claims that a professional DXer can cage upwards of $50,000 a year in relatively tax-free donations, but there obviously is enough in it to keep one or two fellows on the road year in and year out. If it didn't pay they wouldn't do it.

And, once a fellow is off DXing for a business he is forced to find new places to oper-

(continued on page 67)

Editorial Liberties

Apparently I stepped on some toes with my February Editorial Liberties. I dared to suggest that ARRL's OO program might be more effective in the policing of our bands and in recommending that FCC take action against malicious offenders. That segment of the ham population which is opposed to ARRL has been most vociferous in it's opposition.

I'm going to ask two questions, and then try to answer them. The first is: Why ARRL? And, the second: Why has it failed?

The answer to the first is fairly simple. It was obvious many years ago that amateur radio could not stand without an organized body to support it. A look at the Constitution and By-Laws, shows that it is organized along Democratic principles. You elect the person you feel will best represent the interests of your group, and then guide him in those interests. Your Director's job is to take action according to the member's wishes. It works very much like our Federal Government. The voters elect their representative to the Congress, who in turn cast their votes according to the way their constituents tell them to.

The answer to the second question is even more simple. It can be said in one word... "YOU." Back in 1933, a man named Hitler took over Germany. Even long before, a man named Lenin took over Russia. Today, we have our Castro, our DeGaule, our lesser dictators; and why? Because the people really didn't give a darn. They allowed it to happen. ARRL has a fine principle. ARRL has a fine constitution. ARRL could be the democratic voice of amateur radio. Instead it is a closed corporation of people who live for ARRL rather than amateur radio.

Now, I'm going to ask some questions which I am unable to answer. Only you, the reader can answer. Are you a voting member of ARRL? Did you cast a vote in the last election? Do you know the name and address of your Division Director? Did you write to him before the deadline for the coming Board meeting in May? If the answer to any of these questions is "NO," you have no right to criticize. Sitting back and grumbling that things are not going your way won't get you anywhere. The only way to make ARRL work for you is to become involved.

The Ansel Gridley case in Florida is still going on. Grid, W4GJO, is being sued for one million dollars. The plaintiff, who owns a large liquor store in Sarasota, has been advertising in local newspapers with vitriolic anti-ham messages. He has also distributed bumper stickers like the one shown below. Grid has obtained an injunction to prevent further ads or stickers, but if you have ever tried to remove one of those stickers, you know they will be around for a long time. I suggest that large clubs (certainly ARRL won't get involved) should file counter suits against this man for defamation of character in the amount of three million.

With this issue, I sing my "Swan Song." My 22 months with 73 has been rewarding and exciting. However, my forthcoming marriage to K4MWS promises to also be rewarding and exciting and the only deadlines to be met will be mealtimes. We are to be married in May and as soon as I have settled in my new home in Florida and have my feet back on the ground, I will continue as a contributing editor for 73. Thank you all for both your criticisms and your support.

Kayla...W1EMV

Dual Channel Oscilloscope Preamp

Robert G. Teeter
16 Poplar Drive
Rochester, N.Y. 14625

Upgrade your present oscilloscope to have dual trace capability. Don't buy a new scope, instead build a preamp that has the features you want and need. Two channels, each with a separate attenuator, can be displayed one at a time or alternately. The scope sync can be triggered from either input.

The heart of the unit described herein, the switcher and driver boards, were originally designed as part of a systems modification. Seventeen Tektronix 360 type indicators (3 inch oscilloscopes) were converted to dual trace operation. Each oscilloscope was modified internally by adding a pedestal switching transistor, pedestal adjust potentiometer, and 10x amplifier. The switcher boards and driver boards were located on a relay transfer panel under the console. The mode switch and individual gain controls were mounted on the operator's control panel.

By building a switcher board and a driver board and adding some switches and accessories, a good alternate trace preamp can be constructed at moderate cost. The required accessories include power of plus and minus 12 volts, a mode switch and knob, and individual channel gain controls. Optional accessories would be frequency compensated attenuators, switched trigger output and an amplifier. A small modification is required within the oscilloscope itself. The block diagram, **Fig. 1**, shows the general relation of the parts.

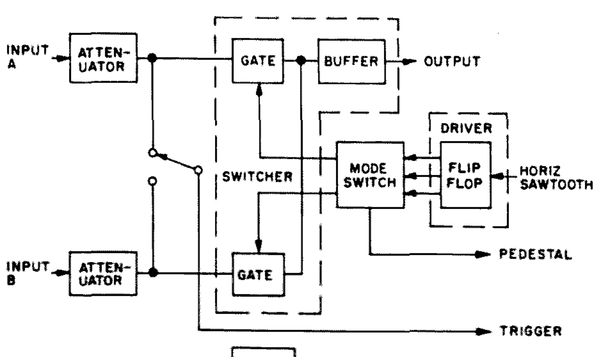


Fig. 1

This is not a step-by-step construction article. Schematics, parts lists, and a description of each circuit will allow anyone who has built from scratch to complete a working unit.

Packaging

Depending on individual desires this unit may be packaged in many ways. First, it could be built entirely within the oscilloscope, if enough front panel space is available for the switches. Secondly, it could be built into a small utility box with one cable, to a suitable connector on the scope. In this case the following functions either go into or come out of the scope (a) 6 Vac for power, (b) horizontal sawtooth, (c) pedestal drive, (d) output and (e) trigger, if the individual trigger is desired. See **Fig. 2**, front panel layout.

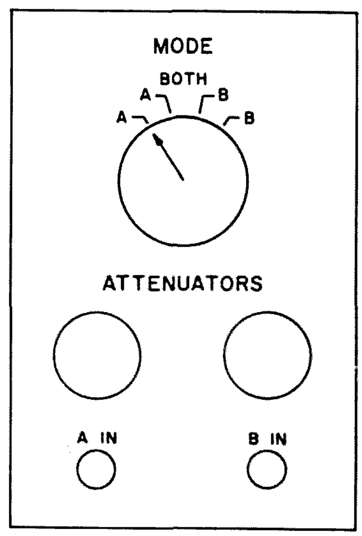


Fig. 2 Panel layout

Power

Power requirements are both plus and minus 12 volts dc at less than 50 mA. Power may be obtained from batteries, a conventional double dc power supply as in **Fig. 3** or from the 6 Vac filaments of the oscilloscope. If the filament supply is used then two voltage triplers and regulating zener are required, as in **Fig. 4.** The voltage triplers eliminate the necessity for a heavy

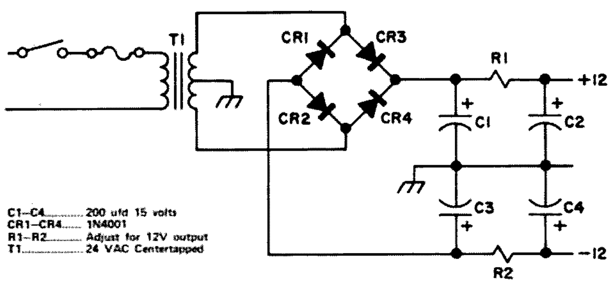


Fig. 3

power transformer, and good regulation is obtained with the zeners. In addition power comes on automatically any time the oscilloscope is turned on.

Switcher board

The switcher board is the heart of the dual trace preamp, Schematic, see **Fig. 5.** Seven Texas Instrument field-effect-transistors are used to alternately pass one signal to the output. For example, if pin F is low and H is high, channel one appears at the output, pin L. If the voltages are reversed, pin F high, pin H low, then channel two appears at the output. Q1, Q4 and Q5 are buffers. Q2 and Q6 are series switches and Q3 and Q7 are shunt switches. The off channel is suppressed more than 70 db.

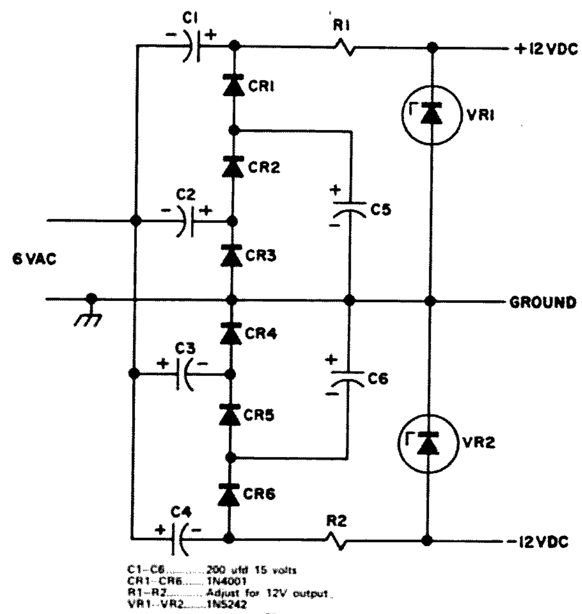


Fig. 4

R14 is used to adjust the output level and R5 adjusts dc balance. If both inputs are connected to ground, then the output, as seen at pin L should be a straight line, not a square wave. Note that to see this another oscilloscope would have to be used, or the pedestal drive to the scope would have to be removed. See discussion under pedestal.

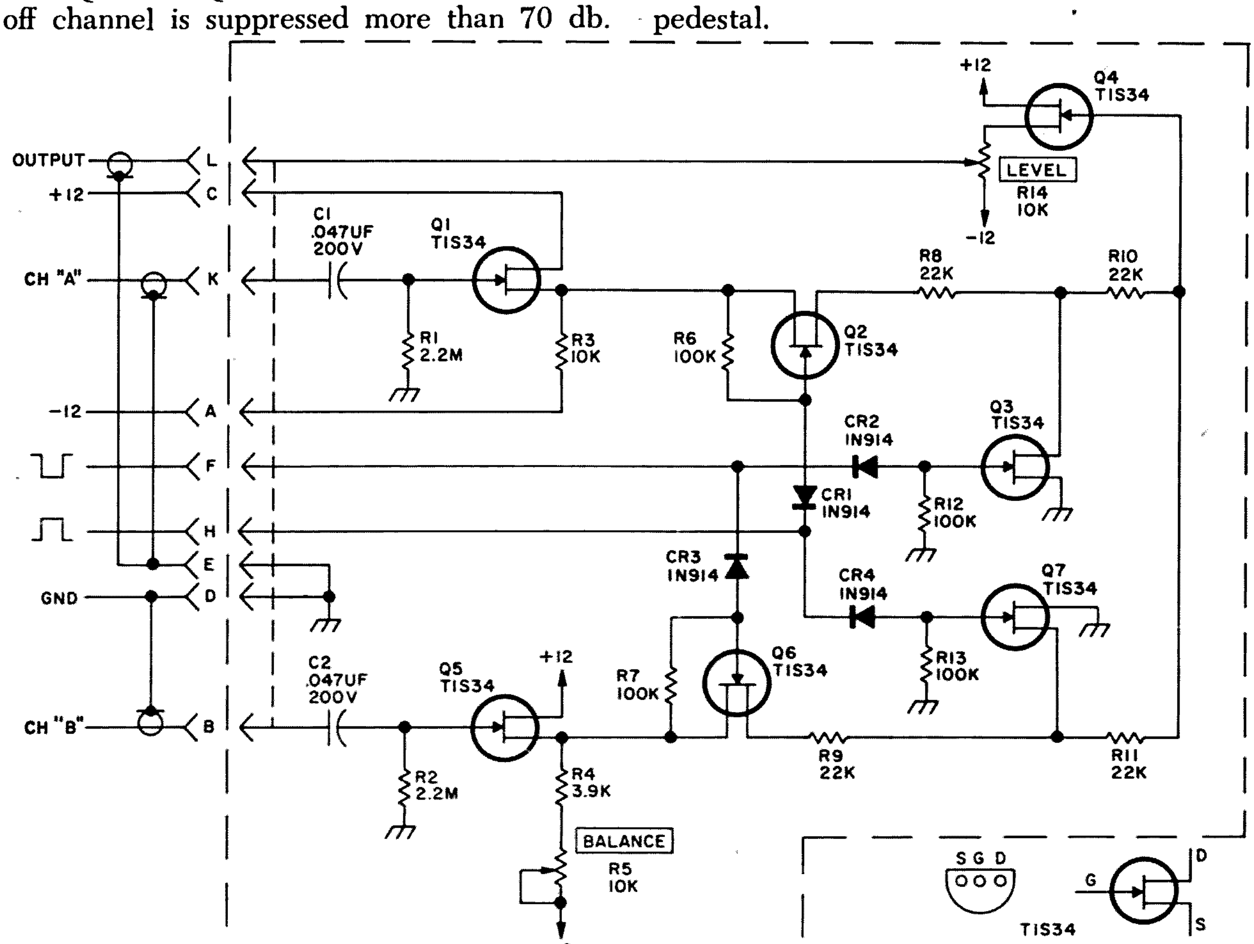


Fig. 5

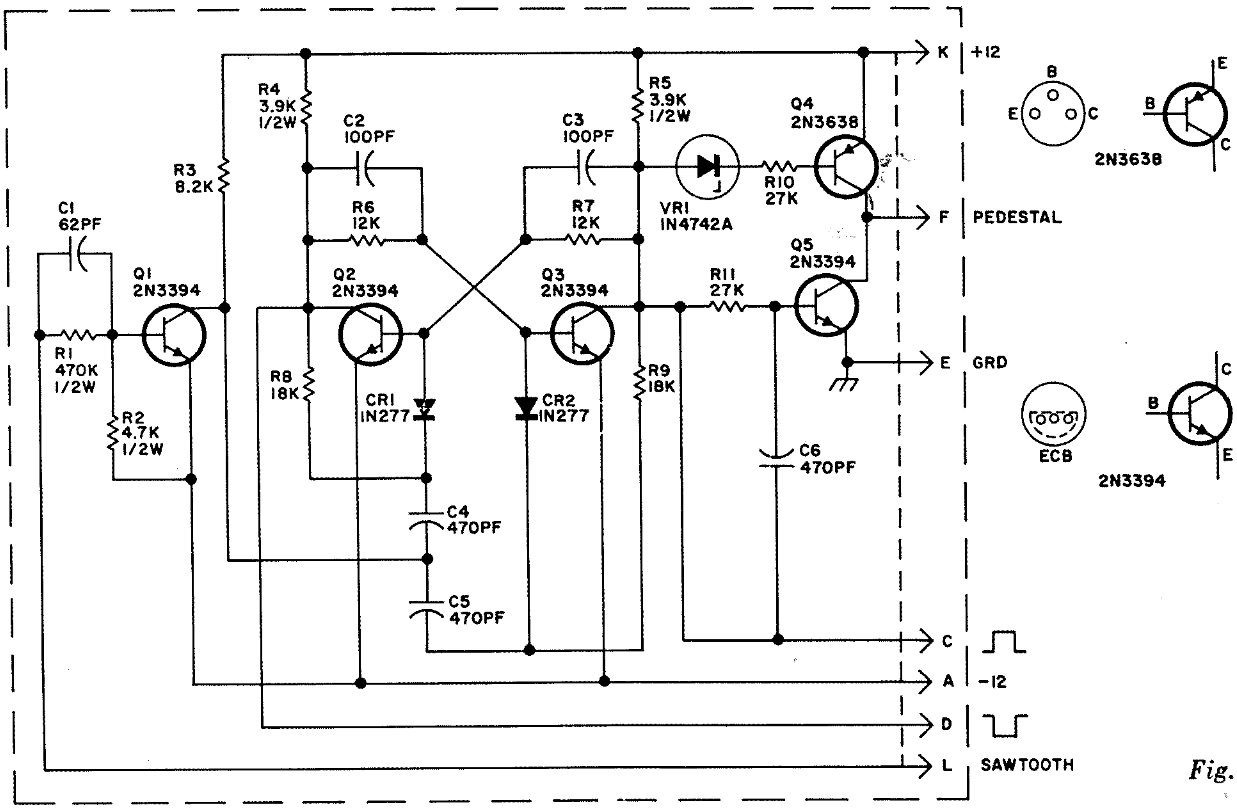


Fig. 6

Driver board

The driver board is basically a flip-flop triggered by the scope horizontal sawtooth. **Fig. 6** shows the schematic. Q1 is a saw shaper. Q2 and Q3 constitute the flip-flop and outputs are taken for gating the switcher board. Q4 and Q5 form the pedestal driver to position the beam on the scope. In conjunction with the circuit discussed under pedestal, the beam is made to go up for channel one and down for channel two, thus the traces are separated on the face of the tube. The driver will switch acceptably for a sweep speed greater than 5 microseconds per centimeter. The inherent rise time of the pedestal, which is the limiting factor, is about 1 microsecond.

Mode switching

The switch positions shown in **Fig. 7** include channel A only, B only, and both, triggered by A or B. It is necessary to switch 4 functions, (a) 2 switcher lines, (b) pedestal line and (c) trigger line.

Pedestal

The internal modification to the scope consists of two parts as shown in **Fig. 8.** First, a connection is needed to the horizontal sawtooth for triggering the driver board. Use caution here as this voltage may be between 100 and 300 volts. This lead should be run in coaxial cable such as RG-174/U. The pedestal lead should also be in coax. The transistor, Q1, causes one side of the push-pull vertical amplifier to be unbalanced, shifting the position of the trace on the screen. Switching occurs pretty much during the sawtooth retrace period. The existing vertical centering control will move both traces equally, while the pedestal adjust control will move only the lower trace.

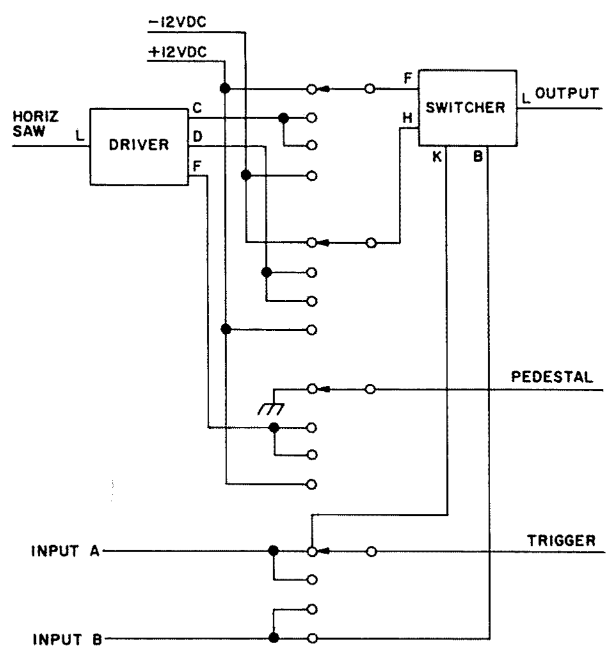


Fig. 7

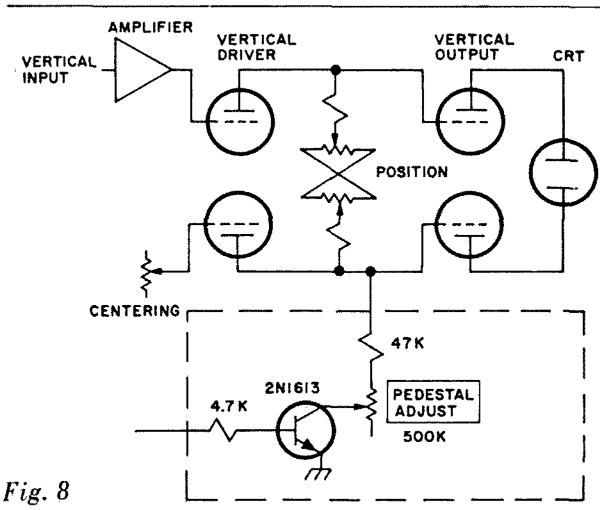


Fig. 8

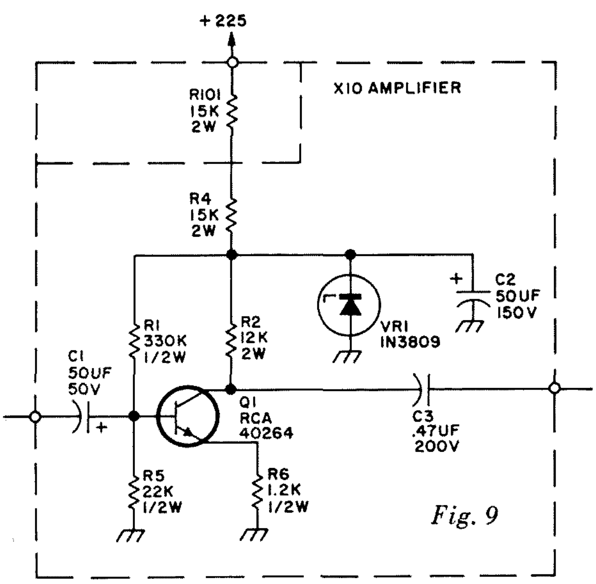


Fig. 9

(Upper trace if you get polarities reversed anywhere.) If it is desired to overlap the traces an easy way to accomplish this is to use a pot that has an on-off switch. Connect the on-off switch between the collector of the transistor and R2.

Attenuator

The attenuator can be a simple potentiometer or a calibrated 10 step attenuator as described in the *Electronics World* article by Donald R. Hicks—"Designing an Oscilloscope Vertical Attenuator." The only requirement is that each input signal to the switcher board be less than about 15 volts peak-to-peak. Otherwise clipping will occur in the FET's.

Amplifier

If desired an amplifier can be added. The amplifier used in the Tektronix modification is shown in **Fig. 8.** This was required in the system modification as the original single attenuator in the 360 indicator was to be used to control both signals. Uncalibrated gain controls were used to vary the levels individually. When the individual gain control was at maximum the original attenuator read correctly.

Printed circuit board availability

Etched and drilled boards are available. Please correspond with author at 16 Poplar Drive, Rochester, New York 14625.

Simplest rf Preamp

Jim Ashe, W1EZT

How simple can a transistor circuit be? Here is a basic *rf* preamplifier, usable from low frequencies to VHF, that must come very near the limit. It looks too simple to work, in fact, but it will do a good job in SWL, VHF, and TV preamplifier applications. Yet it does not compromise in the important bias-stability department as many simple circuits do, and it will accept silicon and germanium transistors interchangeably. The few components can be assembled in almost any convenient style provided the circuit is built on a piece of PC board for good grounding.

The emitter-biased amplifier

We rarely see emitter biasing in experimenter and radio amateur circuits. Perhaps this is because the circuit needs two voltage supply polarities when used in its simplest form. Yet sometimes it is not so hard to use a second battery if the current requirements are low, and a few years ago electronic circuits were expected to need several voltages. Getting by with a single power supply voltage is something of a luxury, which we can exchange for the convenience of a really simple circuit, untroubled by the bias problems often seen in amateur-built gear.

In most of the commonly-used electronic circuits the transistor properties enter into the biasing design. There must be biasing, because the standing bias voltages and currents energize the transistor, and provide power for it to use in amplifying its input signal. But there is one way in which we can bias a transistor which allows the transistor practically no control over its collector current. Using this arrangement eliminates transistor aging, temperature, and replacement effects. We can pull a germanium transistor out of its socket, replace it with a comparable silicon transistor, and discover the circuit works about as well in either case. Very convenient! Specially nice for the hobbyists who must make do with what they have on the bench, or are able to scrounge out of some miscellaneous circuit board.

The complete circuit appears in **Fig. 1.** Although it is a very interesting circuit to industrial designers, unlike many other advanced circuits its basic workings really are simple. Suppose battery B2 is disconnected but B1 remains in the circuit. What happens? A current flows through R1, into the transistor emitter terminal, to the transistor base terminal, and to ground. If the emitter-base diode properties change due to aging or replacement with a different transistor, the current will change only slightly. Using a silicon transistor, there would be only an 8.5% increase in current if we shorted the emitter-base junction. No transistor replacement or type changing, even from silicon to germanium, could produce as large a change as this. Any variations over time in circuit performance must be caused by something other than bias instability.

Now, if we complete the collector circuit by connecting battery B2, the collector terminal will steal the emitter current before it can flow to the base terminal and to ground. The emitter current is practically unchanged, and for ordinary amplifier applications we can ignore the tiny change in emitter-to-base voltage that appears when the collector terminal is energized. This is why emitter biasing is extremely simple and stable. The transistor current is controlled by one single resistor in the emitter circuit rather than by a network jointly including emitter, base, and possibly collector terminals.

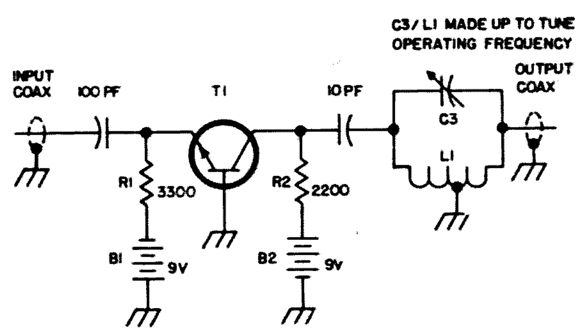


Fig. 1 Complete circuit of the rf preamplifier. Parts values are not critical.

This isn't the best circuit for some applications, and is specially inappropriate for power-amplifier designs. But it works very well indeed for small-signal *rf* preamplifier application because *rf* circuits can easily meet the low input-impedance and high output-impedance requirement set by the transistor characteristics. At audio we would have to use iron-core matching transformers, but at VHF a few self-supporting turns of inexpensive wire will do the job.

A large capacitor, CI, connects the low-impedance input cable to the transistor emitter terminal without upsetting the bias arrangements. Its capacitive reactance should be only a few ohms at the *rf* operating frequency. The values in **Fig. 1** were chosen for operation on the 2-meter amateur band, and the 100 pF capacitor CI has a reactance of around 10 ohms. A 220 pF capacitor might have been a better choice but those available at construction time were not very small.

The collector circuit is a simple shunt-fed resistor-loaded connection via another blocking capacitor to an inverted pi output coupling network. The reactance of C2 at 2 meters is around 100 ohms, much less than the 2200 ohms resistive load or the load coupled back from the output cable. This capacitor, and CI, serve only to prevent outside connections from upsetting the dc conditions in the circuit, and their values are not critical. You should avoid too-large capacitors since these contribute nothing to circuit performance, cost more, and increase the possibility of unwanted resonances.

If we turn a pi-tuner inside out, what do we have? Instead of one inductor and two capacitors with the connection between the capacitors grounded, we have a single capacitor (C3) across the ends of an inductor (L1) which has a grounded tap. We can look at this arrangement as a resonated autotransformer, in which the unwanted coil reactance is balanced out by the parallel capacitor and the impedance transformation from 2200 ohms input to 52 ohms output is determined by the turns ratio on the two sides of the grounded tap. In this case we have six turns grounded at turn #1 from the cable end, which transforms the 52 ohms to roughly 1260 ohms, approximately. The impedance transformation is the square of the turns ratio.

Construction

The construction style is not printed circuit, although the preamplifier is assembled on a piece of copper-clad PC board. There is no transistor socket simply because we can get by without one. This minimizes lead lengths and inductances, and the base lead is soldered directly to the PC board. An input coax connector is eliminated by soldering the braid of the coax input cable directly to the board. Blocking capacitor CI is soldered directly from the transistor emitter lead to the center conductor of the cable.

At the output, LH side, a pair of lugs mounted in the board support the inductor of the output matching circuit L1/C3. The lugs could be replaced by a pair of tiny insulated stand-offs, or a small terminal lug strip to avoid the need for removing some copper. In this case it was easy to solder the small mica compression trimmer C3 between the lugs on the opposite side of the board. The output blocking capacitor C2 is mounted between the transistor collector lead and the input end of the matching network, and the output coax cable center conductor is soldered to the lug supporting the output end of the network. With the cable outer braid soldered directly to the copper surfaced board, another *rf* connector is eliminated.

When I originally built the preamp, I connected the coil to ground a little too far to the right hand side of the coil. This didn't work too well and I had to move the tap to the left. This connection can be moved up or down the coil for best gain, and should not be so far along the coil toward the transistor that the tuning capacitor seems to have no effect.

Resistors R1 and R2 extend directly from emitter and collector leads to convenient lugs situated far enough from the transistor to avoid power lead capacitances from affecting the circuit performance. These resistors are half-watt units but quarter-watt units would work as well. Composition resistors are preferred, rather than metal-film or wire-wound variety.

Operation

Complete the circuit assembly (which may require several minutes) without making the connection from collector to output network L1/C3 via C2. This prevents transistor collector-base diode action from killing coil Q when you try to tune it to frequency using a grid dip oscillator, and it may pre-

vent damage to the transistor too. If you do not have a GDO use coil and resonance equations or nomographs, and provide lots of adjustment. When you reasonably believe the output LC circuit resonates near to or a little above the operating frequency, go on to the next step.

Connect a 56 or 68 ohm half-watt or smaller composition resistor across the preamplifier input terminals, and make the collector battery connection through a milliammeter. There should be no current flowing. Upon completing the emitter battery circuit, the collector current should rise to about 2.6 mA and a VTVM or 20,000 ohms per volt multimeter should indicate about 3 to 4 volts at the collector terminal. Base-emitter voltage should be around 0.3 volts for a germanium transistor, or 0.7 volts for a silicon transistor. If you do not find these voltages check first to be certain battery polarity connections are correct. If you've goofed don't replace the transistor, it's probably all right. Switch polarities and try again.

Now complete the collector-to-output connection through C2, and install the preamplifier in your receiver system. Turn it on and listen for birdies. If there are signs of unwanted oscillation replace the input circuit with a 68 ohm composition resistor and if the birdies remain then move the coil tap nearer to the collector terminals. This increases transistor loading and reduces circuit gain. If you find the preamp oscillates with antenna input but does not with a 68 ohm resistor across its input, then you need to improve your antenna system. It's reactive and needs tuning or corrective mechanical work.

Finally, tune C3 for maximum output. In a TV weak-signal area this will appear as a sharper, stronger picture, and in SW and VHF applications you will observe stronger signals and less noise unless your system noise comes from locally generated interference, in which case there may be more of it.

Additional suggestions

We can easily make this simple circuit more complex. For instance, we can replace CI with a small compression trimmer, adjustable to tune out the small inductance of the cable-to-transistor-and-return loop. This will improve circuit stability by reducing the fedback voltage that collector-to-emitter capacitance can develop from emitter to ground.

We can also improve circuit gain by replacing R2 with an rfc. This choke should have a reactance of several ten-thousands of ohms at signal frequency. 100 MH at 6 meters and maybe 30 at 2 meters looks about right. Then the output matching network can be readjusted for a greater impedance transformation, and signal gain will be increased. Chance of oscillation will increase too, but this arrangement offers an interesting possibility.

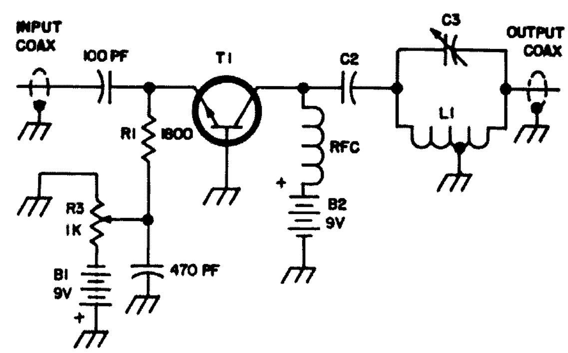


Fig. 2. Suggested variation for improved performance. Operating current may be varied for strong or weak signal work without detuning the output circuit.

With no collector resistor, collector voltage no longer depends upon collector current. We can now adjust collector current by adding a variable resistor in the emitter circuit, which will vary the amplifier operating conditions without detuning the collector circuit. See **Fig. 2.** This circuit is certainly more elaborate than the simple one you may have constructed first, but enables you to choose increased collector current at lower gain to reduce cross-modulation effects, or to adjust the emitter current for maximum gain to hear weak signals.

George Leonard
Associate Editor
Look Magazine

Education and Ecstacy

The following is reprinted by permission of *Look Magazine* and Mr. Leonard. I think this last chapter of his book describes the "magic" quality of amateur radio.

LIFE HAS ONE ultimate message, "Yes!" repeated in infinite number and variety. Human life, channeled for millennia by civilization, is only just beginning to express the diversity and range of which it is easily capable. To deny is to swim against the current of existence. To affirm, to follow ecstasy in learning—in spite of injustice, suffering, confusion and disappointment—is to move more easily toward an education, a society that would free the enormous potential of man.

When men must serve as predictable, prefabricated components of a rigid social machine, the ecstatic is not particularly useful and may, in fact, erode the compartments so necessary for the machine's functioning. But when a society moves away from the mechanistic, when an individual functions as a free-roving seeker, when what we now term "leisure" occupies most of his hours, ecstasy may usefully accompany almost every act. Technology is preparing a world in which we may be life-long learners. In this world, delight will not be a luxury but a necessity.

I can recall little of what happened in school the winter I was 15. Perhaps that was the year everyone in my English class had to do a chapter-by-chapter synopsis of *Treasure Island*. But the afternoons and nights of that period still are vivid. I was infected with the ham-radio bug. My next-door neighbor, a boy two years older, had got me started, and I lived for months in a state of delicious excitement. I would rush home from school, knowing the day would not be long enough. I would work steadily, practicing codes, devouring ham manuals and magazines, pouring over catalogues of radio parts, building simple shortwave receivers. I loved everything about it. When I read Gerard Manley Hopkins's *Pied Beauty,* the phrase, "all trades, their gear and tackle and trim," immediately summoned up the coils and condensers, the soft-glowing vacuum tubes, and sizzle and smell of hot solder, the shining curls of metal drilled out of a chassis.

One night, my radio experience came to a moment of climax. For weeks, I had been working on my first major effort, a four-tube regenerative shortwave receiver. The design was "my own," derived from circuits in the manuals and approved by my knowledgeable friend. Every part was of the highest quality, all housed in a professional-looking, black-metal cabinet. Every knob and dial was carefully positioned for efficiency and aesthetics, and there was an oversized, freewheeling band-spread tuning knob. That night, I had been working ever since running most of the way home from school. I had skipped dinner, fiercely overriding my parents' protests. Now, at about 11 o'clock, I soldered the last connection.

With trembling hands, I connected the ground and the antenna, plugged in the socket and switched on the set. There was a low, reassuring hum, and, after a suspenseful wait, the four tubes lit up. I increased the volume. Dead silence. Nothing. I checked all the switches and dials. No problem there. Perhaps it was the speaker. I plugged in the

earphones. Still nothing.

I couldn't imagine what was the matter. For the next hour or so, I went over every connection, traced the circuit until I was dizzy. Since I had splurged on all-new parts, I didn't even consider that one of them might be defective. The mystery, so powerful and unfathomable, could obviously have been cleared up in a few minutes by any well-equipped radio repairman. But for me, its unraveling was momentous.

The radio's circuit consisted of two stages. The first stage converted radio frequency waves to electrical impulses of an audible frequency; the second stage served as an amplifier for the electrical impulses coming from the first stage. I hit upon the idea of tapping the earphones in at the end of the first stage. Success! Static, code, voices. This seemed to indicate to me that the trouble lay somewhere in the second stage. On an impulse, however, I tied in a microphone at the very beginning of the second stage. Success again. The second stage worked. I could hear my voice coming from the speaker.

In that very instant, the answer was clear: Both stages worked separately. The trouble had to lie in the coupling between them. My eyes went to a little green-and-silver coil (*the broken connection between subconscious and conscious, the hidden flaw between individual and community*). It had to be that impedance coil. With this certainty, I was quite overcome. I would gladly have broken into a radio store to get another one, but my friend, I found, had a spare. I tied it in, not bothering for the moment to solder it. And a universe poured into my room from the star-filled night. I spun the dial: a ham in Louisiana, in California; shortwave broadcasts from England, Germany, Mexico, Brazil. There was no end to it. I had put out new sensors. Where had been nothing, there was *all of this.*

Ectasy is one of the trickier conditions to write about. But if there is such a thing as being transported, I was transported that night. And I was, as with every true learning experience, forever afterward changed.

Every child, every person can delight in learning. Every educator can share in that delight. The methods are available. The needs for reform are clear. The chief obstacles are simply inertia and low expectations. Actually, a new education is already here, thrusting up in spite of every barrier built against it. Why not help it happen, ■

Push to Talk

(The Twoer Way)

Norm Ross VE3ETJ
Box 26, R.R. 1
Dorchester, Ont., Canada

It all started one bad winter day. I was giving road conditions in our area to another local ham when I reached to push down the transmit switch on the twoer. At the same time another car was coming in the opposite direction. The twoer, being out of arm's reach, made me lean over to transmit. This made the car sway towards the oncoming car. If the driver had not headed for the ditch there would have been a real accident. With my heart in my mouth, this brought me to the conclusion that we needed push to talk.

We did it inexpensively without defacing the Twoer in any way. One evening will do the job, and if you have the assembly manual of the Twoer (HW 30), assembly will be much faster when installing the relay.

Step 1.

The relay which we used was a Potter & Brumfield KHP-17A11-12 volt (4 P.D.T.) The relay is mounted upside down between coil CC and socket V4. To hold the relay down in place, a bracket was made and attached to the mounting screw of the relay. When the bracket is attached, move the wiring out of the way between the coil CC and socket V4 and place it so that the bottom of the bracket is below coil CC and the relay about ¼ inch away from the coil. Drill a 6/32 hole and fasten to the chassis.

Step 2.

Now the wiring begins:

At any time you find the original wiring is too short, replace it keeping all the wires close to the chassis when transferring from wafer switch Z to relay. Start transferring the wiring at pin 12 of the wafer switch Z to pin 9 of the relay.

From Wafer switch Z	To: Relay
12	9
11	5
10	1
9	10
8	6
7	2
5	7
4	3

Pins 6, 3 and 2 are left connected to wafer switch Z.
Pin 11 on the relay is grounded.
Pin 12 on the relay is connected to pin 3 of wafer switch Z.
Pin 8 on the relay is connected to pin 2 on coil CD.
Connect a .01 disc capacitor from pin 6 to pin 11 on relay.

Step 3.

Now that the relay has been wired in, we need a voltage to operate the relay coil. I wired in a half wave power supply and filtered it just enough to close the relay. (If relay does not close, take the tension of the spring until it does close.)

The power supply was made on a four pin terminal strip (PS) using a 50 mfd. at 50 volts condenser and a diode. Place this strip under the screw that holds V3 in place coming from pin 1 of the terminal strip S which has a RFC to pin 5 of V3 (6BS8) filament supply. At this point the relay voltage was taken. Drill a ¼ in. hole near pin 1 of terminal strip S. Connect a wire from pin 1 of S to pin 2 of PS. Connect a jumper from pin 1 to pin 3 of PS. Connect a 50 mfd. 50 volt condenser from pin 1 (neg.) to pin 4 (pos.) of PS.

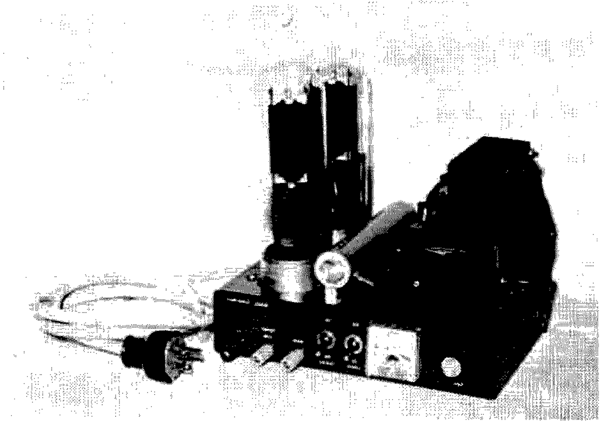
Connect a wire from pin 4 of PS to pin 13 of the relay.

Step 4.

All that's left is the microphone connection. Replace the mic. connector 432-3 with any 4 pin female connector. Pins 3-4 of the connector are grounded. Pin 2 goes to RFC coming from pin 1 of VI. Pin 1 goes to pin 14 of relay. Connect jumper from pin 14 of relay to pin 5 of wafer switch Z. For the mic. cord we used an Armaco TFCC and the mic. was a ceramic with push button. The old transmit switch will still work as if nothing had been changed, except we don't have to reach down and fumble with the switch. We have a tener with the same modification, now all THREE of us are doing fine! . . . VE3ETJ

Variable dc Load

D. P. Bryan, W2AJW
4 Crescent Drive
Applachin, New York



Quite often electronic construction articles go to great lengths to describe the functions of components, their minimum or maximum allowable values and how the circuit works, but end up skimping on explanations about the power supply section. More likely than not they merely state the required voltages and currents and leave the power supply design up to the builder.

Most electronic manuals furnish data and design details for power supplies. If you are the type of builder who can afford to go and buy all new components to build exactly to the handbook design then you won't have any trouble. However, in this world of surplus and used TV set power supply components, most builders turn to the junk box first for the power supply parts.

Since it is rare to find the exact components, even in the best stocked junk box, the builder usually ends up with a power supply constructed with components quite a bit different than those specified. We know it will work but *how well* will it work? Naturally, attaching it to the piece of gear it will power will be the "acid test," but why compound problems? Why try to test and debug a new piece of gear with a power supply that may be bugged because of inadequate regulation or filtering. A power supply defect can really hide itself and show up as a bug on the gear being tested—like distortion in a linear amplifier because of poor power supply regulation.

Why not test the power supply "off-line" before using it?

Here's how.

If you have ten or twenty assorted high wattage resistors or a 200 watt variable resistor in your junk box and don't mind the inconvenience of dropping power to change the resistor or vary the tap then do so as indicated in **Fig. 1A.**

If you have a couple of old transmitting tubes with high plate dissipation, a filament transformer to match, a couple of low wattage variable resistors (one being a potentiometer), a dc milliameter, a small power transformer for bias, and want complete flexibility and ease of control, then do as indicated in **Fig. 1B.**

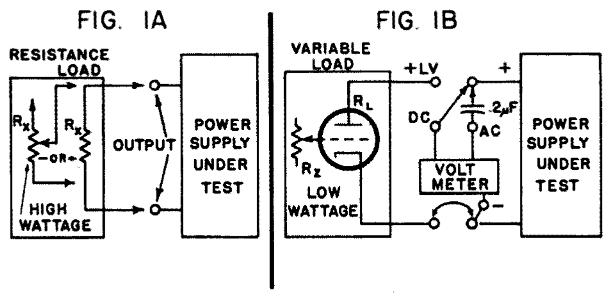


Fig. 1. A high wattage fixed or variable resistance load can be replaced with a triode vacuum tube controlled by a low-wattage variable grid resistance.

Since I had a couple of old VT-4-C's (211's) with big graphite plates rated at 100 watts dissipation each in the junk box, I chose procedure 1B. This decision was also prompted after burning my fingers a couple of times changing hot resistors as in procedure 1A. Actually, any tubes will work. The decision as to type should be made based on plate dissapation rating. Pick the tubes with the highest ratings. The maximum loading and power consumption by the unit will be determined by the plate dissipation of the tubes used.

How it works

Fig. 2 shows the diagram of the variable load. The load consists of tube power dissipators and a bias power supply with a means (R2) of controlling the bias and

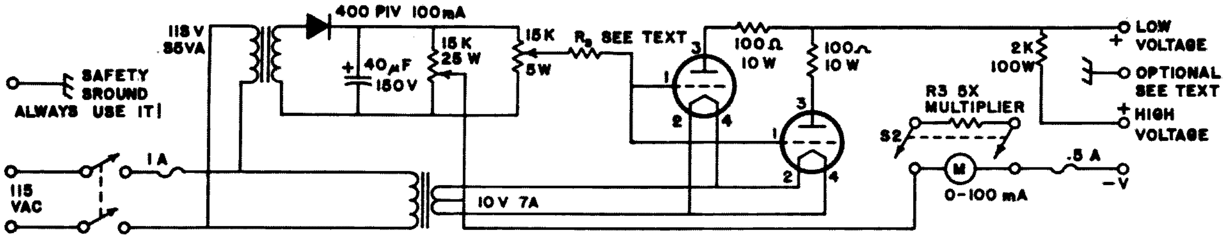


Fig. 2. The practical circuit. Grid and anode re-sistors improve circuit stability.

therefore current drawn by the tubes. A dc milliammeter (M1) is inserted in the cathodes of the tubes to measure the current through the load. The meter has a basic 0-100 dc mA range that is extended to 0-500 mA by switching (S2) a five times shunt (R3) across it to test heavy duty power supplies. A voltmeter is connected between the input terminals (−V) and (+LV or +HV) to simultaneously measure power supply output voltage or ripple and current. The 100 ohm 10 watt resistors in the plate circuits of the tubes are necessary to assure stable tube operation. The resistor in the plate lead from the +HV is necessary if higher than rated voltages will be tested.

As stated earlier the current drawn by the tubes is controlled by R2 which varies the bias on the tubes. Basically, a tube is cutoff (drawing no current), when the grid is more negative than the cathode. A tube is conducting (drawing current), when the grid is more positive or moved closer to the cathode potential. The degree of conduction or current draw depends on the bias setting between these two extremes. Hence the principle of operation of the variable load unit.

Adjustment

The cut-off bias condition of the tubes is set by:

1. Set slider on R1 to mid range.
2. Set potentiometer arm R2 to full minus end. The potentiometer should be wired so this condition exists when the arm is rotated fully counter clock wise.
3. Connect the unit to an external power supply. This supply should be one with a highest output range available which can be used with the type of tubes used in the variable load.
4. Turn on the variable load.
5. Turn on the test power supply.
6. If the milliammeter M1 shows any indication, turn all power off and move the slider on R1 towards the plus end of the resistor. If the meter does not move go to step 7. Turn on power, steps 4 and 5, and again check the milliammeter for a reading. Repeat this step until R1 slider is set at a point that current just stops flowing.
7. If the milliammeter M1 does not show any indication turn all power off and move slider of R1 slightly towards the minus end of the resistor. Turn power on, steps 4 and 5, and again check the milliammeter reading. Repeat this step until R1 slider is set at the point where current starts flowing, then back off R1 slider to the point where current just stops flowing.
8. Steps 6 and 7 will set the bias point of the variable load so that its maximum range of loading can be utilized.
9. Insert a milliammeter between the arm of R2 and the grids of the tubes and measure the current drawn when R2 is set for full conduction. If the value is higher than that allowable for the 5 watt rating of R2 insert a resistor at RS to bring the current back down. The slider of R1 should not be set any closer than 15% of its total value to the minus end of the resistor. This will limit the tube grid current when R2 is set for maximum conduction at the plus end and help prevent R2 burn out.

Grounding

Notice in **Fig. 2** that the only thing grounded to the chassis is the ground conductor of the three wire ac line cord. This will allow testing of minus as well as plus power supplies. The three wire line cord with ground is essential in this application in the event of a short circuit to the chassis. For that matter it is recommended that all electrical equipment be equipped with three conductor power cords. If grounded power cords are not used in your shack then the variable load chassis and the power supply chassis should be bonded together before running any tests.

Operation

In the following two examples the test

set up should be as shown in **Fig. 1B.** The voltmeter should be connected for either ac or dc operation depending on whether measurement of regulation or ripple is the object of the test. Graph paper should be used to plot the progress or results of the test. (It's a lot easier to "see" what a series of numbers represent when they are plotted on a graph.) The graph should be set up with voltage increments on the vertical axis and current on the horizontal axis. The steps or size of the increments will generally depend on the two extremes of the measurement. Try to keep the graph spread out for accuracy.

Once the equipment is set up power is turned on and the load control R2 is turned clockwise until the amount of current representing the first current increment is indicated on the milliammeter. The voltmeter is then read and the indicated voltage is logged as the first spot on the graph. R2 is then advanced to the next current increment and the voltage is again read and logged. This process is continued through the last current increment at which time a line should be drawn connecting each spot on the graph paper completing that part of the test. At this point a component can be changed and the whole sequence runs again to see if an improvement was realized.

These two examples will give you an idea of how it works:

1. Regulation—The graphs in **Fig. 3** were made by testing a power supply using a transformer with an unknown current rating. Two unmarked chokes, L1 and L2, were tied in the power supply to see which offered the best regulation. A dc voltmeter was connected across the power supply output to measure the voltage under the different current settings.

Examination of graphs 3B and 3C shows that the choke used in 3B has 16% better regulation (ac ripple was the same in both cases). The addition of a 10 mfd input filter capacitor and going to a 35 mfd output filter capacitor, **Fig. 3D**, actually made the regulation worse, to 33%, and had little effect on the ripple.

The circuit selected for the power supply was that of **Fig. 3B.**

2. Ripple—The graphs in **Fig. 4** were made to determine the proper value of filter capacitor required to maintain a ripple constant of less than 3%. In this case an ac voltmeter, with a suitable blocking capacitor, is connected across the power supply output to measure the ac component.

FIG. 3

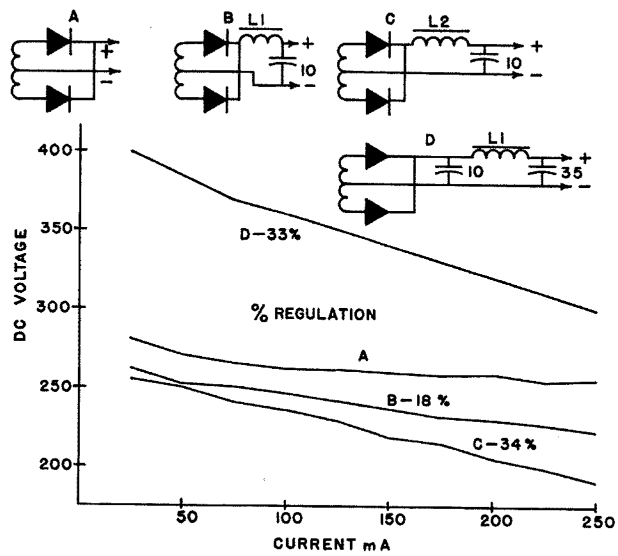


Fig. 3. Test results, obtained quickly and easily, illustrate power supply performance under load.

It can be seen that graph 4B with the 35 mfd filter capacity gives 11% less ripple than the circuit using only 10 mfd of filtering. Circuit 4B also gives slightly better regulation.

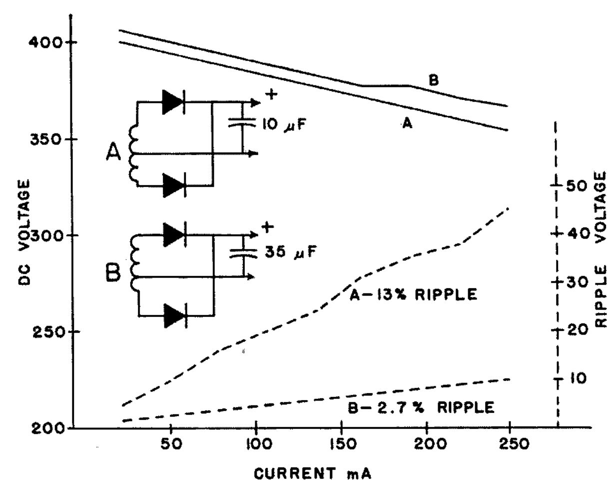


Fig. 4. As power supply load increases, voltage drops together with an increase in ripple.
Variable dc load-Controls left to right: minus voltage, plus low voltage, plus high voltage, ac power/off, meter X5 multiplier switch, meter, load control. The large resistor on the top center of the chassis is in series with the plus high voltage terminal and allows testing of supplies with output capacities greater than the tubes can handle.

These are but two examples of what you can do with a "Variable dc Load." As with anything else, its total effectiveness will be up to the ingenuity and inventiveness of the user.

. . . W2AJW

Single Side SWR Bridge

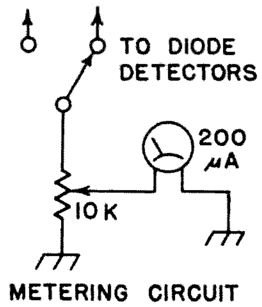


Fig. 1. Metering circuit for the Single-sided SWR bridge.

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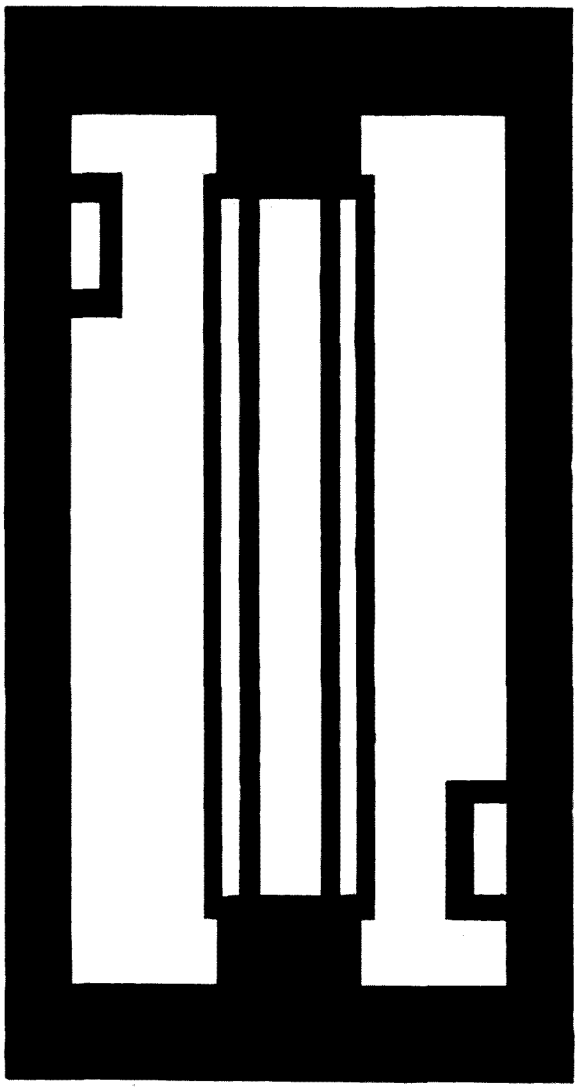
After reading the articles in 73 on SWR bridges that led up to the double-sided board pick-up,* I decided to try my hand at building one, but on single side board.



Several of these boards have been etched and units assembled, and all have been satisfactory. I have used mine, with a 200 micro-amp meter, from a kw on the low bands up to a "Twoer," with no problems with sensitivity.

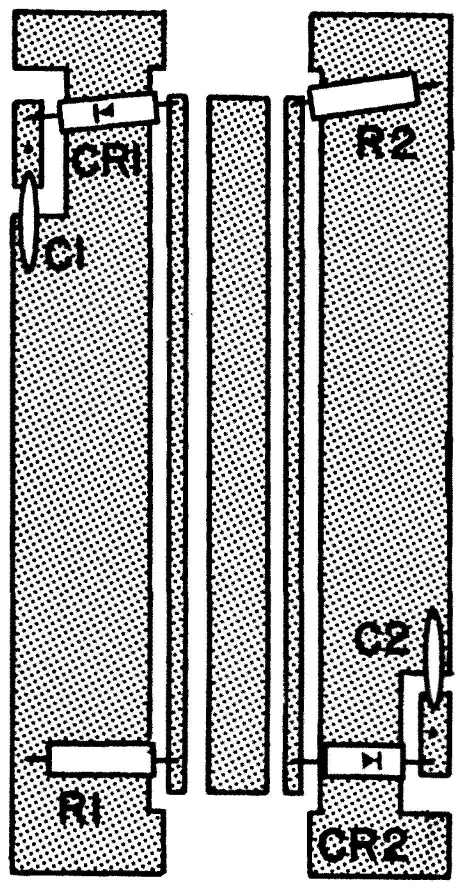
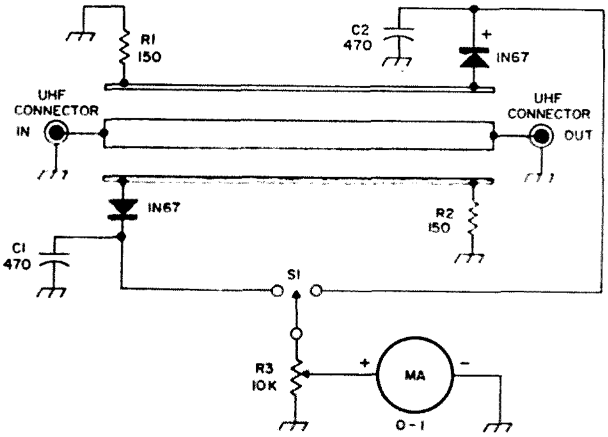
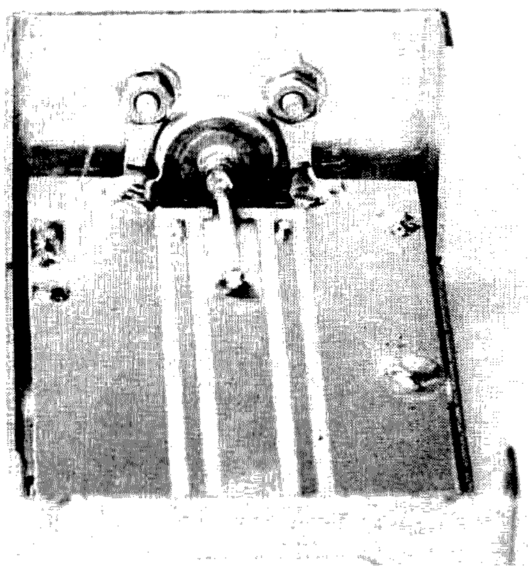


Fig. 2. Layout for the printed circuit board.



Schematic diagram of SWR bridge.

Since Bud Miniboxes are commonly available, I scaled this board to fit into the Bud Minibox CU 2102A or CU 3002A. If you want to include the metering in the same package, the CU 2103A or CU 3003A should be used to give more room.



If you use the CU 2102A, center the coax connectors on the ends. If the CU 2103A, mount the connectors .8 inches from the open end. I used solder lugs bent at right angles to mount the P. C. Board to the chassis. The photograph shows the mounting much better than 10,000 words.

The meter sensitivity control circuit shown has a wider control range than the one shown in the *ARRL Handbook*, since the pot shunts the meter at low settings. This action could be accentuated by putting a fixed resistance in series with the meter movement, at the expense of sensitivity.

. . . WA5SWD

*73, Sept '65

100 KHz Marker Generator

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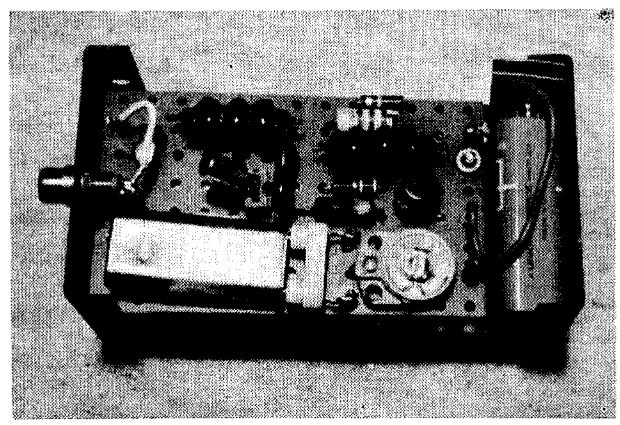
This useful piece of equipment generates usable harmonics from 100 kHz to 225 MHz. It is completely self contained and portable which makes it convenient not only to use in the ham shack, but also in the mobile unit or at a field day location. Its use lies mainly in accurately spotting band edges and 100 kHz calibration points throughout the ham bands.

Most modern day home receivers are equipped with calibrators, but these calibrators are of little use when needed to spot frequencies on VHF and UHF converters or portable equipment.

The generator is constructed in a 2¼ x 4¼ x 1½ inch handi-box. The parts are mounted on a vector board, and the entire unit is powered by one #216 nine volt battery or its equivalent.

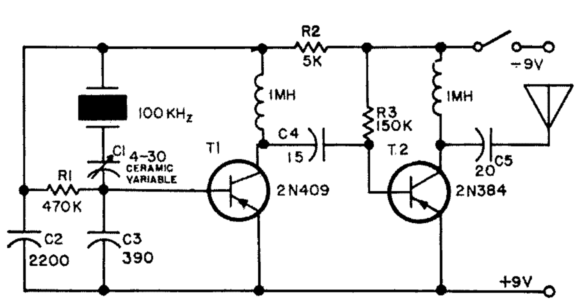
Hints on construction First obtain some vector board. The piece I used was cut from the board supplied in a "GE experimenters aid hobbyist kit." The board must be cut to size before construction and will measure 3½ x 2 inches. This will allow room for the 9 volt battery in the end of the handi-box. Make sure the newly cut vector board will fit inside the handi-box before you start mounting parts. It might save a lot of trimming at a later date.

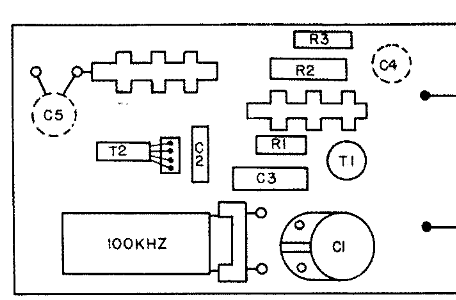
The parts layout is not critical. Components may be arranged as shown in the photo or in any other arrangement suitable to the components you may be using. I used sockets for the transistors, as I wanted to be able to experiment to see which transistors from my junk box would give the most output in the VHF and UHF bands. I ended up using the 2N404 for the oscillator and a 2N384 in the multiplier



stage. I also found that Japanese 2SA83 transistors which had been removed from the *if* stages of a junked transistor radio, would work equally well in both sockets.

All components are mounted on the top of the Vector board with the exception of C4 and C5. For the most part, wiring can be completed with existing leads on components. The push-in terminals furnished with the GE experimenters kit were used for the battery connections, antenna connection and for mounting the crystal socket. The circuit board can be mounted to the handi-box with three 11/16 inch bushings. This leaves room for a slide switch to be mounted on the cover of the handi-box. Two of these bushings were purposely placed at the end of the board to form a sort of socket to hold the 9 Volt battery. The antenna output connector which is mounted on the handi-box is a switchcraft #3501FP phono jack. A small hole may be drilled in





the bottom of the handi-box through which a screwdriver may be inserted for adjusting CI. For extreme accuracy CI is adjusted to zero beat with WWV.

A 36 inch piece of insulated wire soldered into a phono plug may be inserted into the phono jack and used as a test antenna. The intensity of the markers may be varied by moving this test antenna near your receiver antenna lead-in. If you are using a coax lead-in you can couple by drilling a small hole in your coax relay so that the test antenna can be inserted near the relay armature. You will find that most SWR meters provide an easy method of coupling to the center conductor of the coax. As a last resort you can always couple to the receiver or converter antenna coil.

I have made very good use of this gadget to spot frequencies in the 144 and 220 MHz bands. It was well worth the time and effort it took to build it.

...W7CJB

OA2 PECULIARITY

In the process of putting together a small regulated power supply I found myself in need of a convenient stand-off. Unhappily I picked pin 3 of an OA2 gas regulator tube. It seemed like a reasonable choice, but I can assure you that this is not the thing to do.

If you look closely at the tube you will see that the connections from pins 3 and 6 go through the glass envelope and extend about ¼ inch into the tube. They are not connected to any part of the tube. The Handbook shows the pins to be internally connected.

What happens is this: the short pins act like anodes. If you put 500 volts on one of the pins the tube will fire and draw current. In my case there was nothing to limit the current and the tube really went wild!

Conclusion: do not use these pins as stand-offs.

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One Technique to Avoid that Routine QSO

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From time to time amateur radio magazines have all carried editorials and correspondence from their readers directed to the problem of the boring routine QSO ("de W2NSD/1" 73 Jan. 1969; "It Seems to Us" QST Feb. 1969). It has even been suggested that one of the reasons why amateurs often lose interest in their hobby is the uniformity and sameness that most QSO's take. After exchanging a thousand or more reports which simply contain the routine information giving the signal report, QTH, name, power and type of equipment used, followed by the usual "QRU, 73 cul" it is true that the routine QSO can become a dull affair.

Although there has been a great deal written about boring QSO's, very little has been written about what an individual ham can do to improve the situation.

The reason why so many QSO's degenerate into a stereotyped routine exchange of information is in the writer's opinion, the result of several things: First, the operator doesn't know what to talk about and second, he forgets that he is talking to a human being and not just a piece of electronic equipment. Third, the operator is really suffering from mike (or key) fright. As soon as the operator recognizes these facts, something positive can be done to make the average QSO an interesting experience. Many years ago, the writer became aware of his conversational ineptitude at the mike and devised a simple technique which produced excellent results. It may probably have been instrumental in making amateur radio for him a lifetime hobby.

The problem in the first instance is what to talk about after you have completed the routine information. To avoid not knowing what else to say, the writer wrote a series of questions about things that were of interest to him. They were simply things that he would like to ask any new friend that he had just met. Some words of caution are in order, however. *First,* simply asking a lot of questions will not make the QSO necessarily an interesting experience. It is the willingness to share your answers also to the questions you ask with the other fellow that makes for an interesting conversation. *Secondly,* do not ask a question of the other fellow that you would not want to answer yourself if he asks the same question of you. This, however, is really no different than your conduct would be in any social contact with another person. *Thirdly,* the question should not embarrass an ordinary person whose particular beliefs you do not know. One good test is would the information that the question calls for embarrass you if it were asked of you. *Fourthly,* it is not too wise generally to ask questions which you know will invite a controversial answer ("It Seems to Us" QST Feb. 1969). This also is a matter of simple good manners. After all, a QSO should be something that is pleasant for everyone and there are vast areas of subject matter that can be discussed and explored without getting involved with controversial subjects.

The specifics of a program the writer used to eliminate dullness in the QSO require simply listing a series of questions about things of interest to you. Then the moment your mind turns blank as to what to say next or the QSO starts to dry up, simply look at the list and start it up again.

After using the list for a few months, it became almost second nature to engage in friendly informative QSO's, each of which were different from the other and many of which opened the doors for long-term friendships.

As a practical matter, I found that if I volunteered some information first and followed that with an inquiry on the same subject, it would invariably open the door to more discussions and before long a genuine feeling of knowing the other fellow was developed. If you visualize that you are talking to someone sitting next to you as if he were in your own room and not going through a routine testing procedure, the routine stereotype type of QSO which does get tiresome can be avoided. Listed below are the twenty questions which have provided the framework for many pleasant, interesting and diversified QSO's. As you can see, there is nothing unique about the questions. You can easily prepare another list of questions for yourself. The questions are simply guidelines to keep

the QSO going so you will never find yourself in the position of not knowing what to say next. If the questions listed below sound interesting to you, simply use them. If other subjects of conversation come to mind that you would prefer to discuss, then of course, use them. The point of the whole idea is that if you make up a list of questions or subjects and have it on the operating table, you can with a minimum of effort change a boring routine QSO into an interesting conversation with a newly made friend.

My list contained the following subject matter:

1. (I am a machinist.) What kind of work do you do? (If he says he is in school, then ask what school grade, and what does he plan to do when finished.) (If he says he is in college, ask him where it is, what he is taking. If you have been to college, tell him about it.)

2. How long have you been doing that work? (I've been a machinist for 17 years.)

3. (I've been on the air since 1935.) How long have you been on the air?

4. What other bands do you operate? (I operate on 15 and 2.)

5. Do you ever operate any other mode? (I operate part time on CW and part on sideband.)

6. Have you ever visited here in Podunk? (Your town.) I've never been in Lower Culicutt (His town). The nearest I've been to Lower Culicutt was in Upper Culicutt (or where is Lower Culicutt?).

7. (I have been a stamp collector for years.) Do you enjoy any other hobbies?

8. (I wish I had more time to operate. I only get on weekends.) How about you?

9. (I've got two children.) Do you have any children?

10. (My kids are 10 and 12 years old. A boy and a girl.) How old are your kids?

11. Are you interested in DX work? (I am. I've got 110 countries confirmed.) How about you?

12. Have you heard or worked any Dx lately? I've just worked UAØYE in Zone 23 after trying for years.

13. What kind of an antenna do you use? (I use a cubical quad.)

14. (I have (or have not) used the type of beam you have.) Have you ever compared it with any other type?

15. (I've been studying for an extra class ticket for a month now.) Have you started working for an extra class ticket?

16. Do you like to build your own equipment? (I do (or do not) like to build my own equipment.)

17. If he says he does build his own equipment, then ask what he has built, and what will be his next project? Tell him what you have built, and what your next project will be.

18. Are you active on any nets? (I check in regularly on the XYZ net.)

19. Are you ever bothered with TVI? (I cleaned mine up or I still have trouble.)

20. If he is bothered with TVI, tell him how you cleaned up yours.

The preparation of a list of questions or subjects has been a practical solution to the problem for the writer. As a matter of fact, once you have tried the Q and A method, you will find there is generally so much to talk about that it is often necessary to terminate a QSO long before all of the subjects are even mentioned.

While the foregoing idea may not be the only or ultimate solution to the problem, it is at least a step forward toward doing something to avoid those dull routine QSO's. It is perhaps an application of the old saying that "It is better to light one candle than to curse the darkness." ...W6EUV

Minimum Cost Semiconductor Silicon Survey

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Purpose:

Obtain the cheapest silicon transistors from any major manufacturer. Explore possible applications. Develop useable characterization of devices by actual laboratory measurement.

Background Information:

A manufacturer begins with several basic chips of differing geometry, which are then electrically graded into several broad device families. Some will become hi-reliability mil-spec units, hermetic commercial equivalents, house numbered custom spec units, and recently, consumer grade economy units. The economy transistor did not attain respectability until the advent of silicon Planar* technology control which produced high yield uniform quality devices. The residual product remaining after several grading steps still possessed well-defined characteristics and was registered. This gave the familiar 2N . . . designation to these economy units.

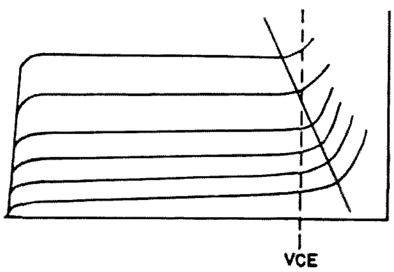
The transistors selected are manufactured by Fairchild and are packaged in either the TO-105 or TO-106 case style (ceramic/epoxy) similar to the TO-5 and TO-18 units. Price shown: 100 pc. lots - 1 November 1968. The study graphically illustrates key parameters which influence cost, and inherent parameters which remain after grading.

To insure reasonable data accuracy, minimum sample (any type) was 100 devices, typical size 300 devices, maximum 100, total 3,300. The devices were procured over an eight-month period (different manufacturing date, codes,) to typify parameter spreads within lot sample sizes most hams would use: Sample distributor sales tend to have more non-uniform parameter distribution than large, bulk O. E. M. sales since most bulk O. E. M. users specify some parameter distribution (not more than 5% of the lot of X thousand shall have parameter Y lower than......or higher than......). This specification is usually derived from the peculiar circuit designs, employed, an uncontrolled family characteristic, or critical limit device requirement. This may produce some unnatural distribution of a key parameter after these sales are completed.

*Fairchild registered trademark.

These abbreviations are used in the article

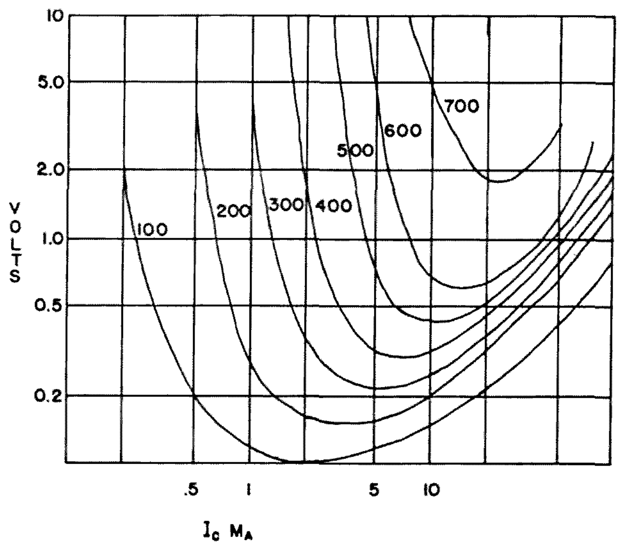
C_{CB} — Collector to Base Capacitance
V_{CBO} — Collector to Base Voltage
V_{CEO} — Collector to Emitter Voltage
V_{EBO} — Emitter to Base Voltage
N_F — Noise Figure
P_G — Power Gain
F_t — Gain Band width Product measured at 100 MHZ
Example F_t = 600 100 MHZ x 6.0
V_{CE} SAT. = Collector Saturation Voltage
H_{FE} = D C Beta
H_{fe} = AC Beta
T_s = Storage Time
T_d = Delay Time
T_R = Rise Time
T_f = Fall Time
Ton = Turn on Time
Toff = Turn off Time



VCE MEASUREMENT

F_t Measurements are made at 100 MHZ. This single measurement will show whether a particular device is capable of high-frequency operation. Specification for Collector to Base Capacitance was used to determine relative merit among devices of similar F_t. Several devices of each type were subjected a 100 MHZ noise test. Devices selected were taken from three F_t groups (low, median, and high F_t). Results were inconclusive. Leakage current was not measured—maximum is 50 Nanoamperes (per spec.) for all types. Beta linearity was measured at several frequencies and collector currents. Condensed data sheet Values are given, a distribution curve is drawn, and then our conclusions. Some devices just do not measure up to the data sheet.

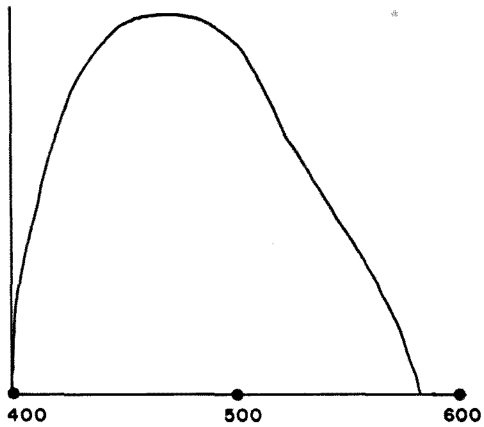
2N5126 – NPNSi RF Amp.
Graded From 2N3688, 2N3689, 2N3690;



FT CHIP CONTOUR 2N5126

Feedback Capacitance C_{CB} = 1.6pf max.
V_{CEO} = 20 Volts MIN
V_{CBO} = 20 Volts MIN
F_t @ 100 MHZ @ 4MA 10 Volts
MIN 300 Typical 600
H_{FE} 20 MIN 70 Typical
350 MAX @ 4MA. 10 Volts
Forward AGC Characteristic
100 MHZ −30db. @ 9MA Typical
NF = 5.5db. Typical @ 100 MHZ.

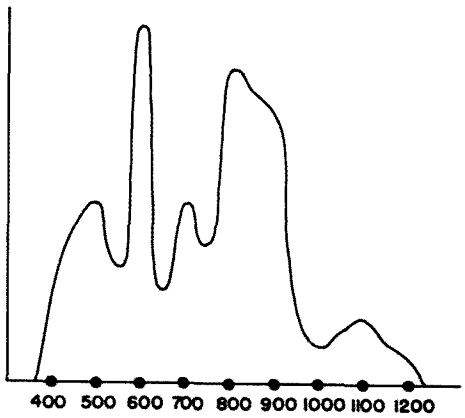
Use: AGC Controlled *if* and *rf* stages of



2N5126 FT DIST

to 100 MHz. AGC Gain reduction vs. current exhibits considerable variation. AGC current and non-AGC'd gain from device to device does *not* track well. This can be helpful to obtain a progressive overload capability to allow wide dynamic range in an *if* amplifier. The 20^{+Y}CE is more than adequate. Noise performance ran slightly more than 5.5 db.@100 MHz. F_t was much lower than anticipated, no unit had F_t greater than 600. A rough approximation of AGC Control current can be obtained, by watching β Compression at higher currents on a curve tracer. The device is useful from 1 to 4 mA., ignoring AGC effect, but there are better types available. High-frequency performance above 100 MHz is erratic due to corner noise and F_t distribution

2N5127 – NPN Si RF
Similar to 2N 3564 *and* SE 1010
C_{CB} = 3.5 pF MAX
2.5 pF Typical
H_{fe} 100 MHz (f_t 750 @ 15 mA.
10 Volts Typical
No MAX or MIN
100 MHz F_t 150 MIN 300 Typical @ 2.0 mA 10 Volts
V_{CB} = 20 MIN
V_{CE} = 12 MIN



2N5127 FT DIST

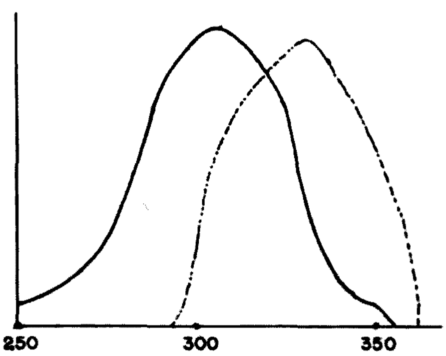
DC Pulsed H_{FE} = 70 Typical
No MAX or MIN
1 kHz H_{fe} = 12 MIN. 80 Typical 400 MAX. @ 2 mA.

Typical characteristic exhibited by actual measurement shows F_t date sheet value is missing from the curve. Units are much lower in β and F_t or are slightly higher—units with F_t 1000 or higher are not β linear. Units of 780 F_t or higher exhibited V_{CE} of about 15 volts. Not as good as anticipated. Units cost 16 cents each. Useable for HF to VHF work if selected. C_{CB} is higher than 2N 5126. Reasonable performance at higher currents (8-18 mA).

2N5128-TO-105 NPN Class – C RF
2N5129-TO-106 High Current Switch
V_{CBO} = 15 Volts
V_{CEO} = 12 Volts
400 Milliwatts Typical @ 30 MHz
G_{pe} F = 30 MHz 12 db Typical
75% efficiency Typical
F_t MIN 200 MAX 800 – 50 mA @ 5 Volts
Pulse H_{FE} MIN 35 Typical 75 MAX 350. 50 mA @ 10 Volts
Pulse H_{FE} Typical 62 @ 500 mA @ 10 Volts
T_{on} 14 ns. Typical I_c 300 mA
T_{off} 80 ns. Typical I_b 30 mA

When swept β measurements were made, units were found to have good Beta at very low currents. Exceptionally good wide range low to high current and linearity. F_t very narrow spread. 2n5123 has higher and F_t curve. It is a nice wide current general Purpose device which reminds me of a 2N2219 but probably not the same chip. I have used it as a current driver/buffer for oscillator amplifiers, tripler drive, large signal *rf* oscillator, audio drivers, and small signal *rf* amps. At 13 cents for either package, this is quite a device.

If higher V_{CBO} and V_{CEO} are required it is



2N5128–2N5129 FT

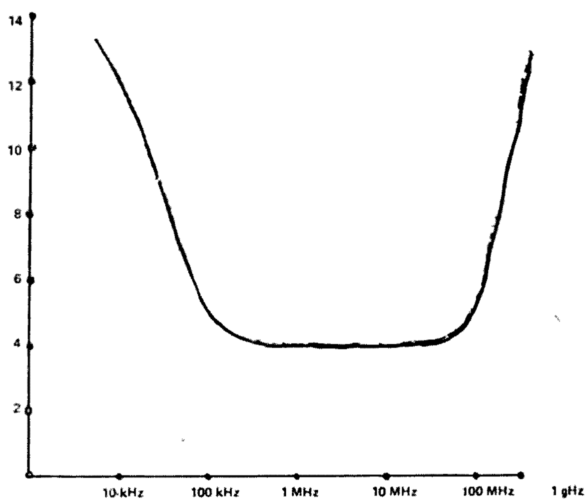
suggested the following similar devices be utilized.

2N3641	V_{CBO} 60 Volts	28 Cents
	V_{CEO} 30 Volts	
2N3642	V_{CBO} 60 Volts	33 Cents
	V_{CEO} 45 Volts	
2N3643	V_{CBO} 60 Volts	38 Cents
	V_{CEO} 30 Volts	

NOTE: These are not devices for operation at VHF frequencies at high power levels—efficiency drops.

2N5130 VCE DIST

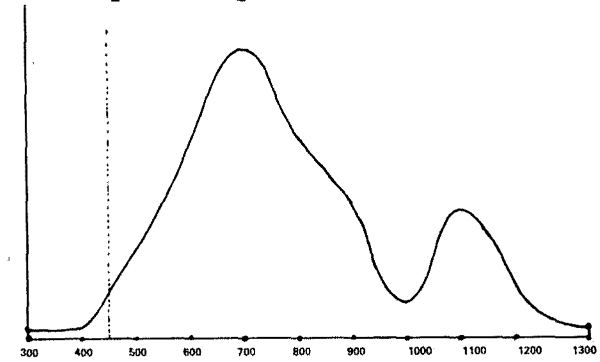
2N5130 – NPN Low Level RF AMP
Similar to: 2N3563, 2N918, 2N2616
F_T Contour
C_{CB} MAX 1.78 pF. @ 10 Volts
G_{pe} = 15 db. Typical @ 200 MHz 8 mA. 10 Volts
P_o = 40 mW. Typical @ 500 MHz. 10 mA. 10 Volts
P_o = 7 mW. Typical @ 930 MHz. 10 mA. 10 Volts
NF = 4 db. Typical @ 60 MHz 1 mA @ 6 Volts



2N5130 Noise Figure vs Frequency Chip Family Chart

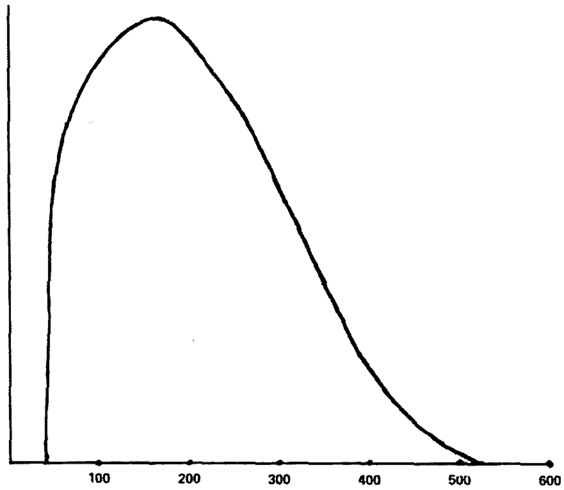
V_{CBO} = 30 MIN.
V_{CE} = 12 MIN.
V_{EBO} = 1 Volt MIN.
F_t = 450 MIN 900 Typical

Most of the transistors were below typical B, typical *rf* Performance, some were out of spec-LO and LO F_t performed like LO 2N918. None of typical specs are met by the majority of devices, though most of the devices perform quite well around 2 meters.



2N5130 FT

Suggested grading in 144 MHz *rf* AMP Stage Biased At 6 to 8 mA. It only costs 11 cents. Good from 100 kHz to ? High Freq. corner unpredictable without F_T Measurement. The 2N3563 costs 30 cents. It is a little better (F_TMIN 600) noise performance similar, 200 MHZ power gain guaranteed MIN 14 db. Hundreds of 2N5130 transistors have been purchased by local VHF FM'ers. They use them interchangeably with 2N918's for local oscillator/multiplier chains, if strips, trigger circuits and mixers. Everyone has been well-satisfied. Since this device was being used extensively the evaluation of this type was reopened in October, 1968 and several hundred additional devices were measured. New test groups were included, and all transistors were tested for V_{CE} Breakdown. High, low and medium V_{CE} units were grouped and were checked

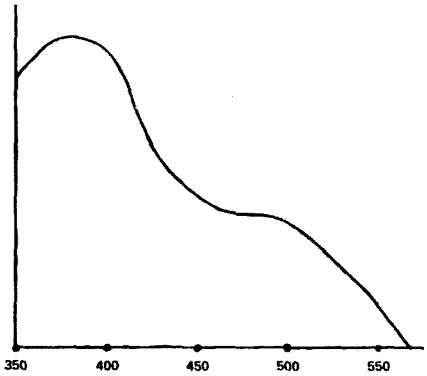


2N5131 1 kHz B Distribution

for Band F_T correlation. Low limit V_{CE} units were found to have low limit B and F_T. High and medium V_{CE} units had random distributions. These low limit units were considered "rejects." Upon removal of these items from the sample the lot was acceptable.

2N5131 — NPN General Purpose
H_{FE} = 30-500 @ 10 mA. 1 Volt
F_t = 100 Minimum I_c = 10 mA. @ 15 Volts
BV_{CBO} = 20 Minimum
V_{CEO} = 15 Minimum
C_{CB} = 6 pF Maximum
V_{CE} Sat = 1 Volt Max
1 kHz hfe = 25 MIN 600 MAX 10 Volts Ic = 10 mA.

A high B unit at 10 mA. Beta falls off at low currents. V_{CE} sat not too good, measurements to high side of spec. One unit considered a "reject" for low F_t. All other units well above minimum F_t Spec. I prefer other devices for specific applications, so have not found any use for this device. Cost: 11 cents.



2N5131 FT Distribution

2N 5132 — NPN AM/FM AMP Graded from 2N3693, 2N3694
VC_{BO} = 20 Volts Minimum
VC_{EO} = 20 Volts Minimum
Pulse H_{FE} 30-400 I_c = 10 mA @ 10 Volts
P_G = 32 db Typical @ 10.7 MHz I_c = 7 mA @ 10 Volts

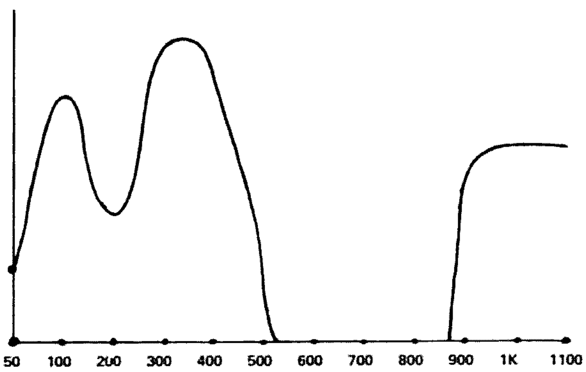
2N5132 FT Distribution

P_G = 55 db Typical @ 455 kHz I_c = 3 mA @ 10 Volts
F_t = MIN 200 Typical 350 I_c = 10 mA @ 15 Volts
V_{CE} sat. = 2.0 Volts
C_{CB} = 3.5 pF max.

This unit tests identically to the 2N3693-94 except 2N3693 and 2N3694 are 45 volt units (minimum). Noise performance was *not* tested. V_{CE} was not very good. The 2N5132 cost 11 cents. 2N3693-4 are 30 cents. Rated better than data sheet limits.

2N5133 NPN Hi-Gain Low Noise
(*Similar to SE*4001, 4002, 4010)
NF = 1.5 db. Typical @ 1 kHz
H_{FE} = 60 Min 220 Typical 1,000 Max @ 1 mA 5 Volts
H_{FE} = 50 Typical @ 50 mA.
V_{CEO} = 18 Volts MIN
V_{CBO} = 20 Volts MIN
V_{CE} Sat = 0.4 Volts Max
h_{fe} = 50 Min 1100 Max @ 1 mA 5 Volts

The curve tells the story. Something is missing. Some current fall off at low currents. Reasonable NF for most work between 1 kHz and 5 MHz in preference to most other NPN Bipolars. It has nice V_{CE} sat compared to other types. It costs 11 cents. It is good from 20 mA to 3 to 4 mA range. Difficulties were encountered with some units used in an audio circuit due to oscillations which occurred at about a 10 MHz rate. Some units are very noisy. Check to insure this is really noise, not spurious oscillation. Several hundred units were checked.

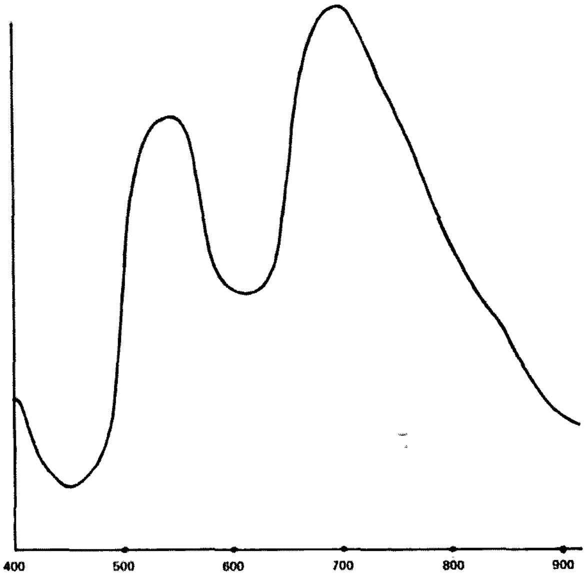


2N5133 B Distribution

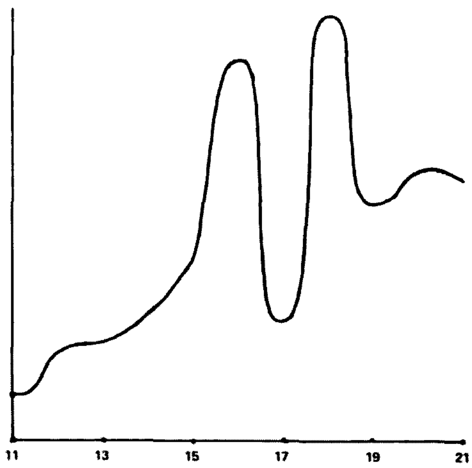
2N5134 NPN Hi Speed Saturated Switch
(*Similar to 2N*4274, 2*N*4275, 2*N*3011, 2*N*2369)
V_{CE} Sat .25 @ 10 mA MAX Ib = 1 mA
.20 @ 10 mA Ib = 3.3 mA
C_{CB} = 4 pF MAX 2.3 pF Typical
V_{CES} = 20 Volts MIN
V_{CBO} = 20 Volts MIN

V_{CEO} = 10 Volts MIN (10 mA Pulse)
Ton – 8 ns Typical 18 MAX
Toff 7 ns Typical 18 MAX
F_t MIN = 250 MHz @ 10 mA
F_t Typical = 575 MHz

Beta correlates with F_t. Good V_{CE} Sat. Useable at currents under 1 mA. Nice *rf* amp at 5-20 mA. Not too bad NF either, to 200 MHz. Beta linear. It costs 13 cents.



2N5134 FT



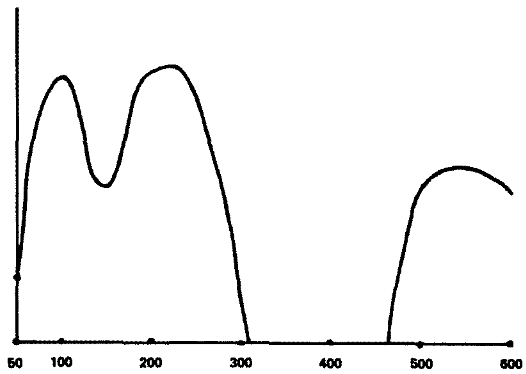
2N5134 VCE Distribution

The 4274 and 4275 Transistors cost 29 and 30 cents. I use it in *rf* Oscillators, pulse inverters, 4 V logic circuits, 6 V lamp drivers, xtal controlled multi's. Good value. May be matched with 2N5140 as complementary pair.

2N5135—NPN High Gain
to —105 Package
Gradeout of 2N3566 similar to SE6001, 6002
Pulsed h_{FE} Min 50 Typical 400
Max 600 @ 10 mA 10 Volts
Pulsed h_{FE} Min 15 Typical 325
I_c = 2 mA @ 10 Volts
V_{CEO} = 25 Volt MIN
V_{CES} = 30 Volt MIN
V_{CBO} = 30 Volt MIN
V_{CE} Sat Typical @ 0.9 Volts
MAX 1.0 Volts @ 100 mA
Ib = 10 mA

Summary:

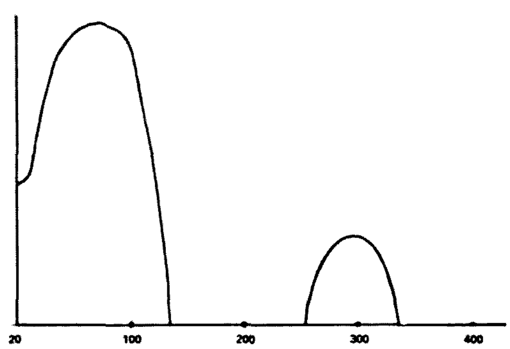
The curve tells the story. Typical value is missing. Transistor is good for audio drivers general purposes to about 10 MHz. Device selection can be made by one measurement. It costs 14 cents. The 2N3566 is 24 cents. V Sat not too good for switching applications. Device noise level in most units was lower than the 2N5133. It has much higher breakdown voltage. Good value; have hundreds measured.



2N5135 B Distribution

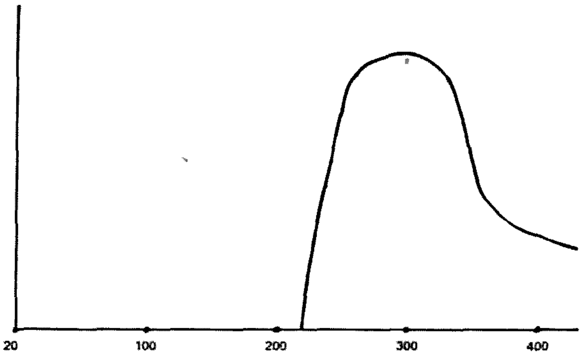
2N5136 – 2N5137 NPN General Purpose Amp.
(*Graded from 2N3567, 2N3568, 2N3569.*)
V_{CBO} = 30 Volts MIN
V_{CEO} = 20 Volts MIN
Pulse H_{FE} Minimum 20 Typical 100 Maximum 400 @ 150 mA 1 Volt
C_{CB} = 16 pf Typical 35 pF Maximum
V_{CE} Sat. = 0.25 Volt Max. @ 150 mA.

The Curve tells part of a story. The swept beta collector family curves showed a pronounced Beta peak at 1 to 3 Volts V_{CE}. Beta was not linear. The curve looked similar to 2N1613 series chips. Pulsed Beta measurements per spec are made at the point where Beta has theo peak. On some units this may be more than three times Beta at normal load line points. Switching



2N5136 B Distribution

characteristics are reasonable. C_{CB} is considered to be very high which makes this device unsuitable for *rf* applications. This is not a very high frequency device. Unit Cost is 11 cents. The 2N5136 is packaged in the TO-105 case, 2N5137 in the TO-106 case. The 2N5137 had higher Beta. Not Recommended.



2N5137 B Distribution

This concludes the NPN Portion of the Survey. Transistors I was most impressed with were the 2N5128, 2N5129 Due to extremely good linearity over a wide current range, and nice switching characteristics. The 2N5134 I use as substitute for 2N706, 2N2369, 2N3011, because the epoxy case is much nicer than a unit with a "hot" case (Collector connected to case) (Case does not radiate switching noise).

The 2N5126 is handy for gain controlled applications in the *if* region; *if* devices are selected for this characteristic.

The 2N5130 is useful for *rf* Amps, although it did not meet expectations.

The 2N5135, and 2N5133 are nice for low frequency work if it is measured, and the 2N5136, 2N5137, 2N5132, 2N5131, 2N-5127 find less application.

Most applications do not need any higher V_{CBO} and V_{CEO} than the above devices in each category provide. For most ham work I prefer discrete components to LIC's due to the poor noise performance, power supply voltage restrictions, and signal handling capability of the integrated circuits.

The preceding data is based on actual measurements, care has been taken to insure reasonable accuracy. It cannot be implied through such data that manufacturing tolerances will allow devices to be shipped to maintain the peculiar distributions measured here; however, the results seem to show exactly what would be expected for the lowest cost devices sold in the U.S.A. since anything much better would be sold at a higher price. Careful study of these meas-

urements (a portion of which are shown) seem to confirm their validity, for the purposes, stated in this study.

Here is the PNP Portion of the minimum cost transistor Survey.

2N5138 – PNP Low Level Amplifier. Graded from 2N4246, 4249, 4250

Typical Unit exhibits Low Noise 0.7db @ 1 kHz I_c = 20 mA @ V_{CE} – 5 Volts

H_{FE} = 100 Typical I_c = 100 @ 10 Volts

V_{CBO} = –30 Volts Minimum

V_{CE} = –30 Volts Minimum

V_{CE} Sat = 0.3 Volts Maximum I_c = 10 mA I_b = 0.5 mA

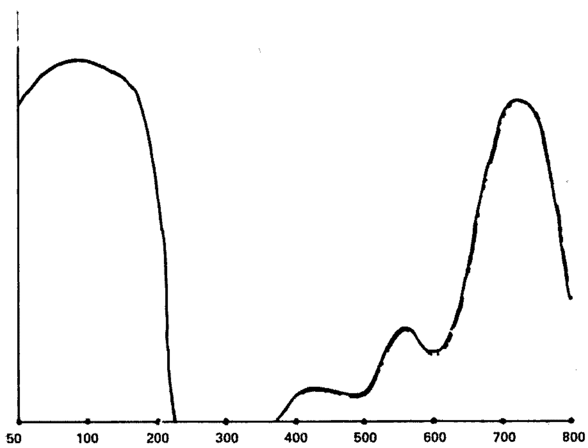
C_{CB} = 7 pF Maximum

A β Linear Transistor with good V. Sat. Useable Current Range 20 Micro Amp. to 50 mA frequency Range 50 Hz to 2 MHz. Low noise performance requires Device Selection. Suitable For Video Amplifier Service to About 4.5 MHz.

F_t up to 300 MHz @ I_c = 3 mA V_{CE} = 10 Volts

Price 11 cents.

Several hundred of these have been used. Device was compared to 2N4248. (Price 16 cents.) Results were similar. 2N4249 is 38 cents. 2N4250 is 40 cents. This series has V_{CE} 40 Volts with 4249 V_{CE} 60 Volts.



2N5138 B Distribution

2N5139 PNP High Speed Switch and *rf* AMP Graded from 2N4916, 2N4917, 2N4121, 2N-4122.

H_{FE} = 150 Typical @ 10 mA

F_t 500 MHz Typical @ 10 mA

C_{CB} = 2.2 pF Typical

V_{CEO} = –20 Volts Minimum

V_{CBO} = –20 Volts Minimum

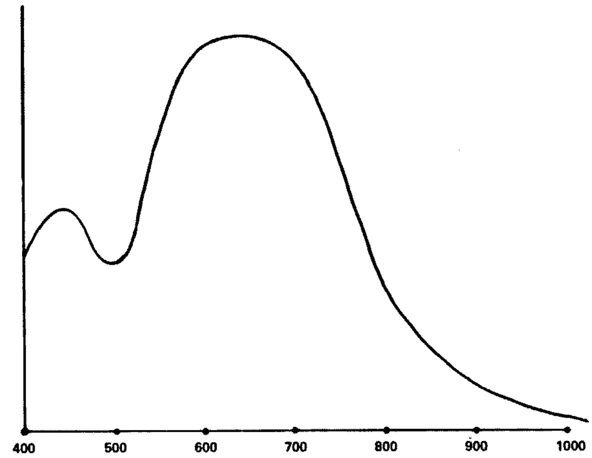
H_{FE} = 30 MIN 70 Typical @ 100 mA –10 Volts

MAX V_{CE} Sat 0.15 Volts @ 1 mA

MAX V_{CE} Sat 0.20 Volts @ 10 mA

MAX V_{CE} Sat 0.50 Volts @ 50 mA

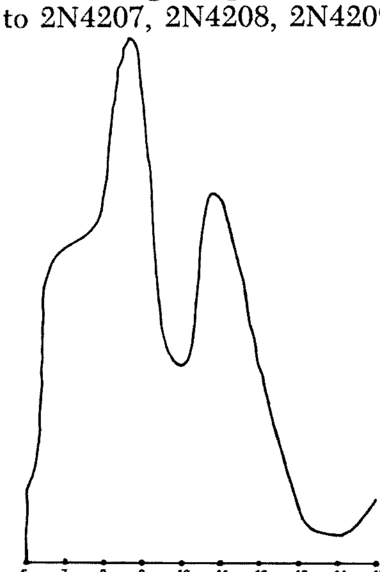
F_t was measured at spec point



2N5139 FT Distribution

A plot was made using 100 devices. Additional 200 devices were purchased. Another curve was drawn. Two more large lots were purchased. The final curve shows F_t distribution for nearly 1000 devices. The smaller lot curves were almost identical. Only one device had F_t = 300 all the remaining devices had F_t Minimum 400 Typical 660 Maximum 1000. Useable frequency range for best noise figure 1 kHz to 100 MHz on selected units. F_t remains high at 1 mA (Typical 300). Switching characteristics good. A very nice device. Price: 11 cents. 2N4916 costs 16 cents was compared. Results similar. 2N4917 is 36 cents. 2N4121 38 cents, 2N4122 41 cents. It appears only parameters comprised are breakdown voltage, and upper corner noise frequency. Used for *rf* amps, Overtone oscillators, a general purpose replacement for PNP Germanium transistors, one was to replace A 2N1142 and performed satisfactorily.

2N5140-Ultra High Speed PNP Switch Similar to 2N4207, 2N4208, 2N4209

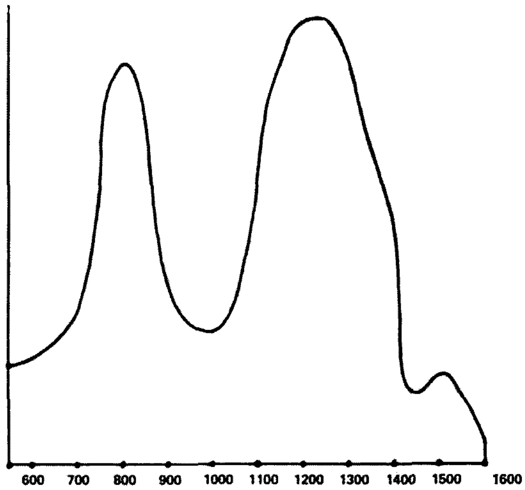


2N5140 VCE Distribution

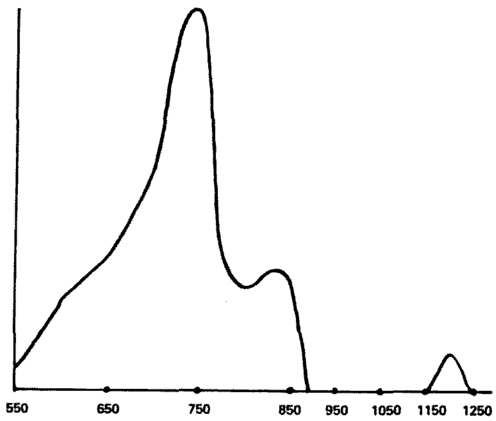
V_{CBO} = −5.0V MIN
V_{CEO} = −5.0V MIN
V_{EBO} = −4.0V MIN
F_t = 400 MIN 1000 Typical
−5V @ 10 mA
C_{CB} 2 pF Typical
Ton = 20 NS MAX
Toff = 20 NS MAX
V_{CE} SAT = 0.2 MAX

This device had the highest F_t measured. Superior performance observed in these applications: Logic interface broadband amplifier, pulse shaper, and trigger circuits. Beta falls off at lowered current. Device with F_t = 1200 @ 10 mA has F_t = 900 @ 5 mA, F_t = 500 @ 2 mA F_t = 150 @ 1 mA. Voltage breakdown V_{CE} was also measured. Both V_{CE} and F_t were better than anticipated. Price is 13 cents. Nearest equivalent Types 2N4207, 2N4208, 2N4209 are priced $3.00, $3.50 and $5.50 respectively. High performance at low cost.

2N5141 — PNP Hi Speed SW
Ton = 90 NS MAX
Toff = 150 NS MAX
C_{CB} = 3.3 pF Typical
7.0 pF MAX
100 NS MAX



2N5140 FT Distribution



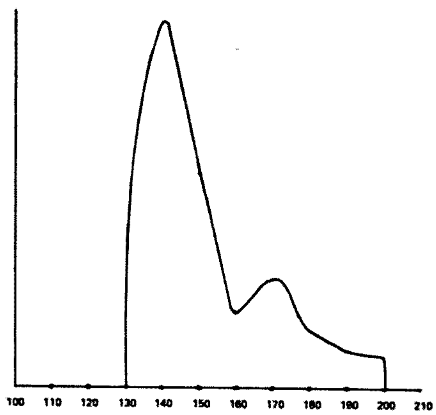
2N5141 FT Distribution

T_D = 4 NS MAX
45 NS MAX
T_R = 6 NS Typical
70 NS MAX
F_t = 300 MHz MIN
1200 MHz Typical
TS = 12 NS Typical
T_F = 3 NS Typical
70 NS MAX
V_{CE} SAT = 0.7 Volts MAX
V_{CBO} = −6 Volt MIN
V_{CEO} = −6 Volt MIN
V_{EBO} = −6 Volt MIN
V_{CES} = −4 Volt MIN

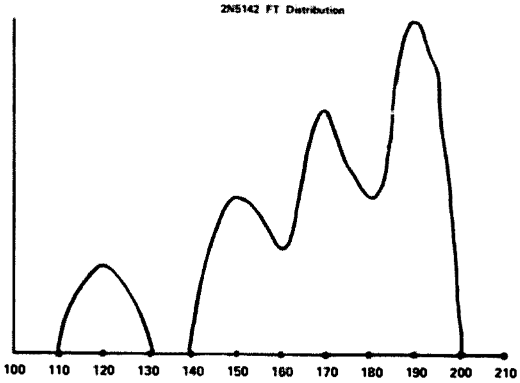
F_t of 1200MHZ Typical not confirmed by measurement. Switching parameters very wide spread. Low breakdown voltage, rather high C_{CB}. I have not found a good application for the 100 PCS I've measured. Cost is 16 cents.

2N5142—PNP High Current Switches
Toios Case
2N5143 – PNP TO-106 Case
(*Similar to* 2N3638, 3638A)
V_{CBO} = −20 Volt
V_{CEO} = −20 Volt
V_{EBO} = −4 Volt
H_{FE} Min 30 Typical 70 @ 50 mA 1 Volt
C_{CB} = 4.5 Typical 10 pF MAX
F_t = 100 MIN 190 Typical 50 mA −3 Volt

F_t falls off Between 5 mA and 1 mA significantly. Suitable for high current line drivers, medium speed switching. Good V_{CE} Sat. over current range. I use it as a voltage regulator current driver. Appears to be a low voltage 2N2905 with low β at lowered currents. It costs 16 cents.



2N5142 FT Distribution



2N5143 FT Distribution

One Other Device is worth mentioning:
2N5163 – N – Channel LO Noise JFET
Very Low Noise
e_n = 12 NV Typical e_n = 50 NV/Hz (MAX) @ 1 kHz
1.0 kHz NF = 0.1 db (Typical) @ 1.0 mA
Rds ON = 500 MAX
125 Typical
I_{dss} MIN 1 mA
Typical 14 mA
V_{ds} = 15 Volt V_{GS} = 0
MAX 40 mA
V_{SG} = 25 Volts MIN
V_{DG} = 25 Volts MIN
V_{DS} = 25 Volts MIN
I_{dss} was typically 22-26 mA
At V_{GS} = 0 Lowest was 14 mA
Highest 36 mA

It is supposed to be a very low noise unit per specs: Most are. An audio amplifier that was built using this device had no difficulty picking up several local radio stations. At 35 cents each in lots of 100, it is reasonable enough to experiment with.

Summary:

PNP transistors I was most impressed with were the 2N5138, for beta linearity, and excellent video amplifier service, the 2N5139 for all general *rf* applications, and the 2N-5140 for high speed switching. Most applications do not require higher voltage breakdown devices than this series of semiconductor devices will provide. It is hoped some individuals will consider this series suitable and incorporate these devices in planned construction projects.

I am reminded Fairchild is *not* the sole vendor source for this semiconductor series. No estimate can be made concerning quality or parameter distribution of an identical type supplied by another vendor.

An estimate can be given concerning the parameter distribution of one typist, not supplied by any vendor, without whose patience this article could not be completed, so at this time I must thank Miss Carole A. Hussar, and add this comment . . . a pretty, blond, young secretary-typist need not supply a data sheet for publication . . . none of the readers of 73 would be interested. ■

Heathkit SB-610 Monitor Scope Modifications

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Proper optimum operation of single sideband transmitters is most easily achieved by oscilloscope monitoring. As a result, the Heathkit SB-610 Monitor Scope* is appearing in more and more amateur shacks as a vital piece of equipment. As originally designed, this equipment is a versatile piece of gear. There are a couple of modifications, however, that make this an even more versatile instrument.

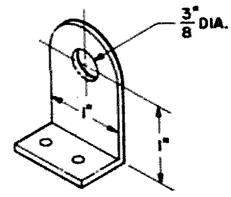
I will describe two modifications that I have made to my SB-610. Neither modification requires new front panel holes or mechanical changes to affect the resale value of the SB-610. Most owners of the SB-610 should consider at least the first modification. Those who have yet to acquire an SB-610 may wish to incorporate the modifications when they construct the kit.

Transmitter attenuation switch

This modification moves the transmitter attenuation switch from its present position in the center of the rear apron of the SB-610 to the front panel. The control becomes concentric with the present vertical gain control. With the transmitter attenuation control on the front panel, it is no longer necessary to reach behind the SB-610 to change the transmitting pattern height when changing power levels or making band changes. This is especially useful when one changes bands frequently or where a linear amplifier is often switched on or off.

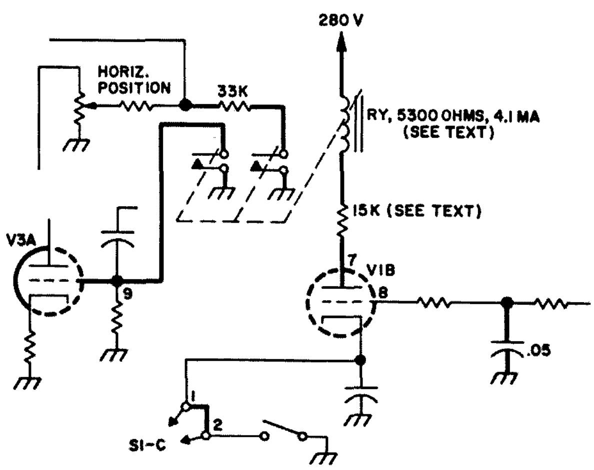
Parts required:

Concentric potentiometer element (outer unit) and shaft assembly, 100 K linear (IRC-CTS CF 13 or equivalent, see text)
Potentiometer mounting bracket (See **Fig. 1**)
Non-conducting shaft (3⁄16 inch diameter by 10 inches approx.)
⅜ inch "butch plug"
Lever knob*
Control knob split bushing*



Mounting Brackett

In this modification, the present 100 K linear vertical gain control, which is in the lower center of the front panel, is replaced with a 100 K linear concentric potentiometer. A Heathkit lever knob, matching the present SB-610 knobs, is put on this new potentiometer. This leaves a hole through the center of the vertical gain control in which to run



Modification Schematic

the insulated shaft which controls the transmitter attenuation switch which is remounted on a new bracket facing forward.

The choice of concentric potentiometer is not critical and by browsing in your local parts house stock of replacement type controls you should find a "make your own pot" selection enabling you to assemble the "outside" portion of a dual potentiometer. (I used an IRC-CTS CF-13 unit with a panel bushing about ⅜ inch long and a shaft about

*"Heathkit SB-610 Monitor Scope," *73 Magazine*, (December 1966), 54.

*Order Heathkit numbers 455-11 Split Bushing $.10 and 462-195 Lever knob $.50 (postpaid) from: Heath Company, Benton Harbor, Michigan 49023.

⅝ inch long which I cut to exactly fit the Heathkit lever knob.)

Remove all three wires to the lugs of the old vertical gain control (AJ in the SB-610 manual) and remove the old control and knobs keeping the wires in order so they may be soldered to the new control. Before mounting the new pot, be sure that the knob shaft will extend just far enough to allow you to mount the new lever knob on it. Do any cutting of the shaft before mounting the potentiometer to prevent damage to the front panel of the SB-610. Mount the new control and resolder the wires to the corresponding lugs of the new control.

Fabricate a bracket as shown in **Fig. 1** and refer to the photos to see mounting details. (If you are lucky as I was, your junk box will yield a suitable bracket.) Unsolder the wire from the coaxial connector to the lug 4 of switch BD, the transmitter attenuation switch, and unsolder the capacitor which runs from terminal strip G, lug 5 to terminal 5 of switch BD. You can now remove the switch from the back apron. If you wish, fill the empty hole in the back apron with a "butch plug."

Mount the new mounting bracket in line with the old hole in which the switch was mounted. Allow enough room for the switch to be remounted between the new bracket and the back apron. Mount the switch and reattach the wire from the coaxial connector to terminal 4 and the capacitor to terminal 5 of the remounted switch. Orient the switch so this can be accomplished with the least difficulty. Be certain that no components stick up far enough to interfere with the case when it is replaced over the Monitor Scope.

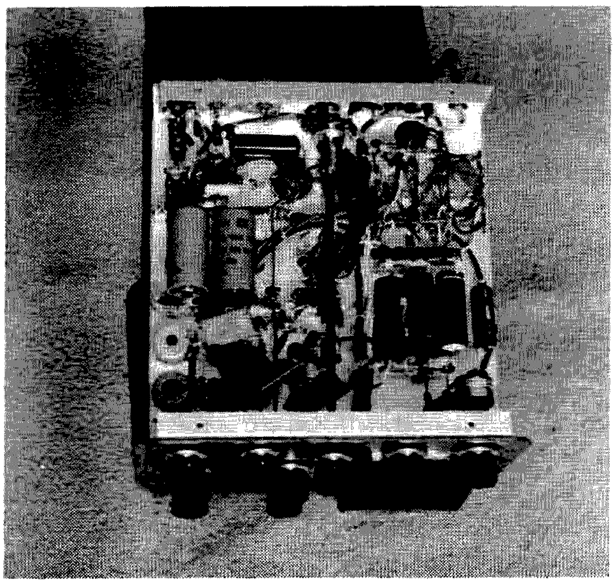
Attach the shaft coupler to the switch shaft and insert the 3/16 inch non-conducting shaft extension from the front panel into the hole through the vertical gain control running it back to the shaft coupler. Carefully move any parts that interfere with the shaft. The large .25 mfd capacitor near the shaft coupler between the tube socket (V3) and the terminal strip G may need to be relocated to provide sufficient clearance. A metallic shaft extension is *not recommended* due to the possibility of accidental contact with parts on the chassis.

When the shaft has been properly mated, make a small shim from a piece of scrap or tin can to reduce the ¼ inch coupler on the switch to accept the 3/16 inch shaft extension. With the shaft in place measure ½ inch beyond the lever knob mounted on the vertical gain control and remove and cut the shaft at this point. Mount the shaft firmly, tightening the coupler. Use the new split bushing inside the original knob removed from the vertical gain control to firmly fasten the knob onto the shaft extension flush with the lever knob.

The SB-610 will now operate exactly as it did originally. It is now possible to select the vertical gain when monitoring a received signal using the lever knob and to change the transmitter attenuation using the large original knob. It is no longer necessary to reach behind the SB-610 each time the linear is turned on or off or each time you need attenuation changes when switching bands.

Clamp Modification

This modification should appeal to those people, myself included, who believe that the main virtue of the SB-610 is the monitoring of one's transmitted envelope using the internal sweep. If you use the internal



Top View

sweep *without also monitoring received signals* during standby periods, the trace of the SB-610 will remain a static baseline of high intensity since the clamp circuit is inoperative in this mode. This can cause a burned scope face if the intensity is high enough for good monitoring of peaks in a brightly illuminated room. I decided that I would like to remove the trace from the scope face automatically when the transmitter is turned to standby. This could be done using the relays that switch the rig from transmit to receive, but since my rig is a transceiver

that I also use when mobile, this would involve additional connections to attach and remove each time I switched from base station to mobile operation. My modification accomplishes the clamping of the trace with no additional connections to the transmitter or receiver.

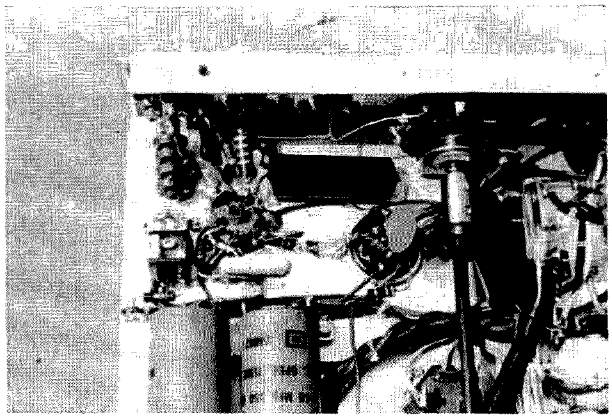
Parts required:

Capacitor, .05 mfd, 50 volts
Resistors: 33K, ½ watt and resistor in series with relay coil (see text)
Sensitive plate relay, DPST, N.O., (Lafayette Radio 99H6093, DPDT, 5300 ohm, 4.1 ma., 4 oz., shipping weight, $2.95, Lafayette Radio, 111 Jericho Turnpike, Syosset, L.I., N.Y. 11791) See text for details.

The relay I used, was from my junk box. Lacking a suitable relay, the one listed in the list above is suggested. It may require ingenuity to mount some relays, but a small bit of epoxy will do wonders if properly applied.

Fig. 4 shows the circuit modifications to be made. The dark portions of the circuit are additional components or modifications. The clamp tube, V1B, is turned into a relay amplifier. Relay contacts are used to pull the trace off the screen by shorting the horizontal position control through a 33 K resistor. A second set of contacts grounds the grid of V3A to stop the sweep. If the sweep is not disabled, the left portion of the trace will still be on the screen. Pins 1 and 2 of the front panel sweep control are jumpered so that the "pull for clamp" control will work in the internal sweep position of the sweep control as well as in the other sweep positions. When this modification is made, the SB-610 will operate as originally designed in the RTTY and *rf* Trap positions of the sweep switch. The clamp will also work in the internal (Int.) position of the sweep control when the "pull for clamp" control is pulled out. The clamp switch may be pushed in so that received signals may also be monitored as originally designed.

The .2 microfarad capacitor on terminal strip H adjacent to tube socket VI is changed to .05 microfarads to allow 1 to 2 seconds before the trace leaves the screen. This capacitor need not be changed, but the time for the trace to leave the screen will be in excess of ten seconds if it is not changed. Remove the capacitor from strip H and replace it with the .05 mfd capacitor if you desire this change.



Bottom View

The left hand lug of terminal strip U, near the chassis edge was originally unused. Remove the blue wire at pin 7 of VI and solder it to this unused lug of terminal strip U. On the back of the front panel, solder a jumper wire between lugs 1 and 2 of the sweep switch.

Mount the plate relay in the space between the tube socket VI, terminal strip U and the edge of the chassis. If your relay can be mounted with screws as could my junk box relay, that is fine; otherwise you may have to use some ingenuity and perhaps some epoxy to mount the relay.

From one set of relay contacts (closed when the relay is operated) run a wire to a convenient ground point such as the mounting lug of terminal strip U. From the other contact of the set, connect the 33 K resistor to the blue wire which you soldered to the previously unused lug of terminal strip U near the outside of the chassis.

From the second set of contacts (also closed when the relay is operated) run a wire to ground. From the other contact of this set, run a wire to pin 9 of tube socket V3A which is the tube socket near the shaft extension. This set of contacts will now ground the grid of tube V3A when the relay is closed and stop the sweep.

Run a wire from one end of the relay coil to the 280 volt bus. I ran the wire to the junction of the 40 mfd capacitor; 15 K, 1 W resistor; 1 K, 1 W resistor; and 20 mfd capacitor. This is near the center of the chassis on capacitor K, pin 3.

Temporarily, attach the remaining end of the relay coil to pin 7 of VI through a resistor. (This resistor should be nominally 15 K ohms for the relay in the parts list.) The resistor should be selected so that the relay used just pulls in reliably when the

clamp switch is pulled out, the SB-610 turned on, and no *rf* signal is applied. In any event, the plate dissipation of the 6BN8 relay amplifier should not exceed the maximum rating of 1.7 watts. The total resistance of the relay coil plus series resistor should be at least 10 K. (If you use a junk box relay, measure the voltage from cathode to plate, and the current through the tube when the relay is pulled in. The product of the voltage and current—in amperes—should not exceed 1.7.)

This completes the wiring of the modification. Check the wiring against the schematic in **Fig. 4.** Carefully plug the SB-610 in with it still out of the case and let it warm up. Check to see if the relay operates when the "pull to clamp" switch is pulled out and the sweep switch is in any position. If the relay does not operate, first recheck the wiring to make sure it is correct. If the wiring is correct and the relay will still not pull-in, reduce the value of the resistor from the relay coil to pin 7 of VI until the relay reliably pulls in. This will assure that minimum plate dissipation occurs in tube V1. When this value is found, solder in the resistor permanently.

When the "pull to clamp" switch is pushed in, the relay should drop out. The trace will then appear on the face of the SB-610 and it should operate normally.

Set the sweep switch to Int. and apply a small amount of transmitter *rf* to the connector at the rear of the SB-610 while the "pull to clamp" switch is out. The relay should release and the trace should appear to allow normal transmitted signal monitoring. If the trace does not appear and the relay drop out, increase the *rf* signal. When the *rf* is removed by turning off the transmitter, the trace should disappear after 1 to 2 seconds. If the trace has not moved completely off the scope face, it may be necessary to decrease the value of the 33 K resistor. If the sweep still continues when the trace is off screen, the grid of tube V3A (pin 9) is not being shorted to ground through the relay.

I have operated my SB-610 24 hours a day for days at a time and experienced no difficulties. You must now remember to turn off the power switch after operating, for you no longer see the green trace on the screen to remind you that the SB-610 is on.

. . . K6SDE

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VHF FM Station Control

Being addicted to the use of FM on the VHF ham bands, I decided to establish a system of communications equipment for two of the most popular bands.

In the area where I have been living 2 and 6 meter FM are the most popular.

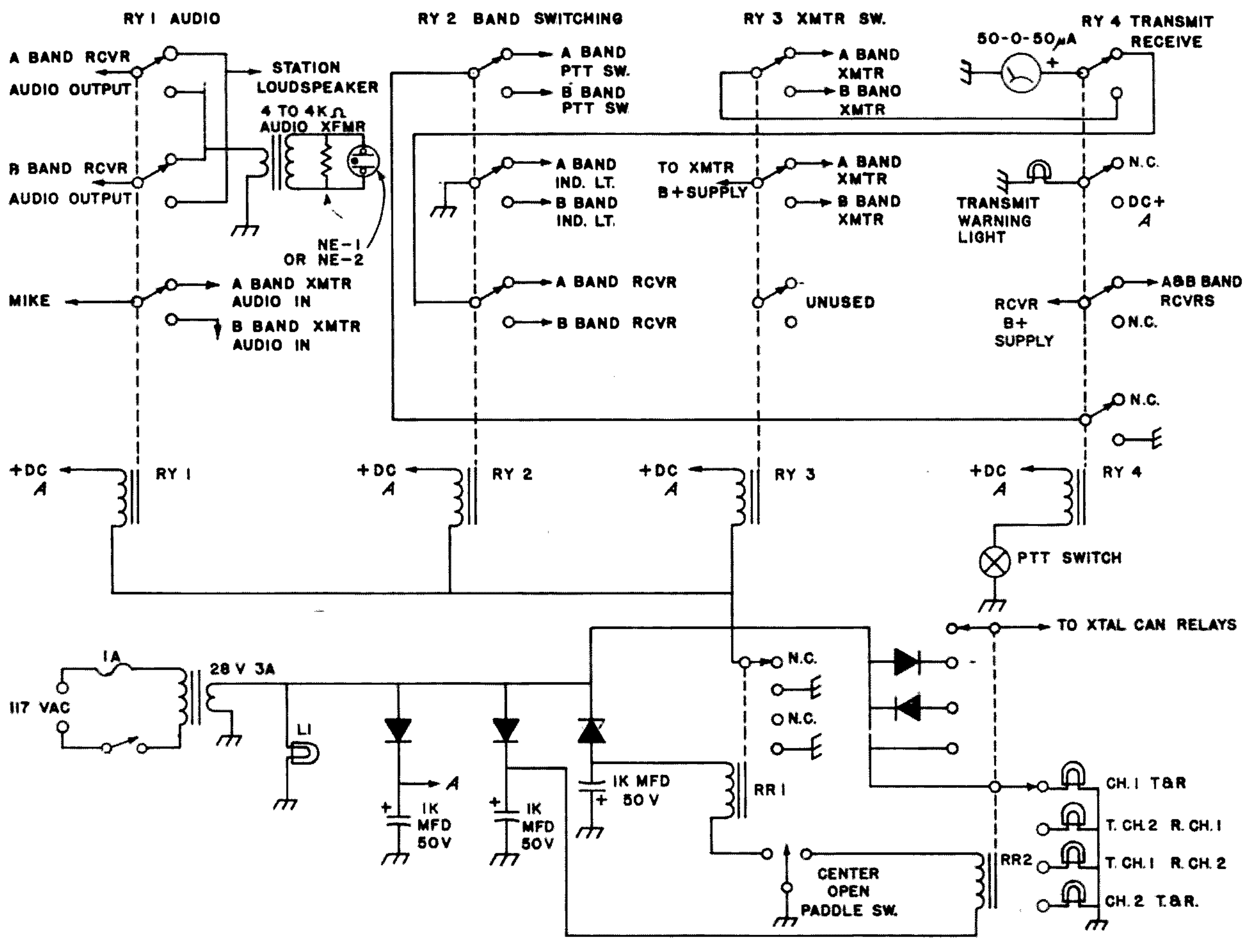

Fig. 1. The station control unit. RR1 changes bands each time the paddle switch is pushed to the left, RR2 changes channel setup in either band when paddle switch is pushed to the right. Lamps in lower LH corner of the schematic indicate which of four channel tuning schedules is in effect.

The unit to be described has provisions for two band operation as well as two separate transmit and receive frequencies on each band.

The unit makes use of surplus parts and is very straightforward in its operation.

There are two rotary-ratchet relays in use, one is set up so that every other terminal is grounded. When this relay is stepped, it alternately energises or deenergises relays ry1 through ry3. These relays take care of the bandswitching function. Provision is also included for automatic switching of metering. The other rotary relay applies a series of pulses to crystal-can relays in the various transmitter and receiver units. The first step applies no voltage to the relays. The second step applies a positive pulse at 28 vdc to the relays triggering one set. The third step applies a negative pulse to the bank of crystal-can relays triggering one set and releasing the other. On the fourth and final step 28 vac is applied to the bank of relays triggering both sets. This works out very well in conjunction with a local repeater, allowing either direct contact or contact through the repeater.

A fourth relay Ry4 has the duty of switching the receiver voltage for muting as well as the metering and keying the PTT. This relay is keyed to ground through the PTT contacts on the microphone. The PTT circuits of both transmitters are keyed every time the PTT is energised, however only the selected transmitter is operational as the power is switched through a set of contacts on the band s selector relay.

This unit has been in use for several months and works out very fine. It saves wear and tear on the operator during band switching operations.

Also included is a second band monitor. Both receivers are running continuously. One is feeding the speaker while the other is feeding an audio output transformer hooked up in reverse. If there is any audio present on the second band it will light 19.

Channel switching is done by means of small dpdt relays. These relays, due to their physical size are called "crystal-can" relays.

One is used in each transmitter and receiver and wired so that the wipers connect the crystal across the the crystal socket. The relay used in t this manner reduces problems, due to the fact that there is only one crystal in the circuit at any one time. One lead is connected in parallel with all other relays and goes to the wiper of Rry2. The other lead of the coil goes to ground through an appropriately polarized diode. It is well to have like relays keyed at the same time. That is both transmitter and both receiver relays keyed together. A provision is included for lamps to indicate which channel is in use at any one time and a chart is easily made to call out just what each lamp indicates.

The purpose of this is not so much for construction of exact duplicates but to open the doorway for thought and design to meet your own personal requirements.

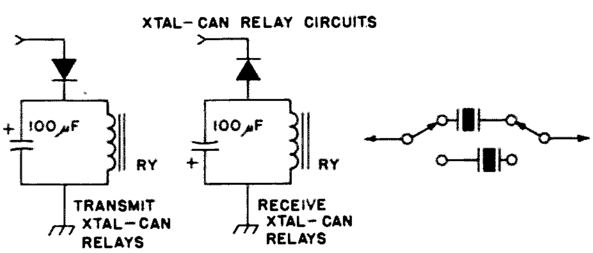

Fig. 2. Series diodes determine applied voltage polarity that will operate the crystal-can relays. With added capacitors, relays will operate reliably on ac, which is applied during some Station Control settings. Note relays switch both sides of the crystal circuit.

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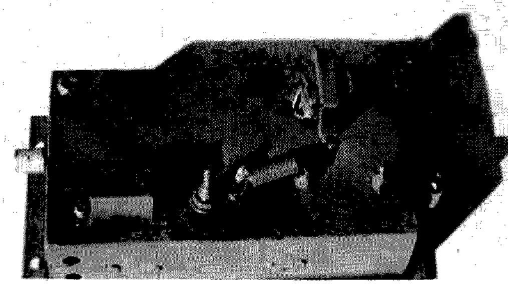
A Simple Portable Rig For Six

With "mountain topping" becoming a popular sport on the VHF bands, a low power portable transmitter for 50 MHz can be a handy item. This article describes such a transmitter that is not excessively difficult to build and provides a good signal on six meters.



The Circuit

It was finally decided that the one watt power level offered a fair compromise between battery weight and power. Only two stages are needed to generate the desired power, and this simplifies construction. Both the oscillator and amplifier are power modulated for maximum audio "punch." The modulator is a PA-222 one watt integrated circuit amplifier. With the addition of a few external resistors, capacitors, and a transformer, this unit offers one watt of audio at a price comparable to commercially manufactured amplifiers. It is surprising that integrated circuits have not become much more popular with the amateur fraternity.

The RF section was adapted from RCA designs, and is a standard configuration. It was necessary to hold the supply voltage to 22½ volts to prevent destruction of the transistors. It is theoretically possible to generate instantaneous voltage four times the supply voltage in a modulated transistor transmitter. In this case this rating is exceeded, but the theoretical maximum is usually never reached.

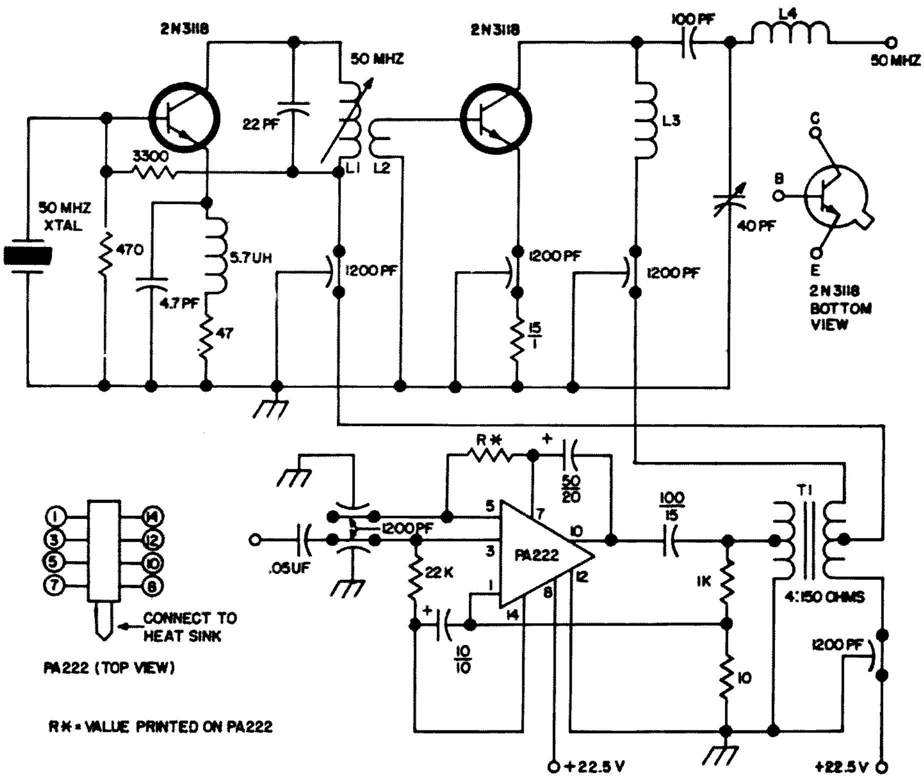
In order to obtain full modulation the oscillator must be modulated along with the final. Careful tuning of the oscillator can minimize FM, but for optimum results, it would be best to add a driver stage so that the oscillator would not be modulated. However, in this case, simplicity and power consumption were more important, and careful tuning gave very good results.

Construction

The transmitter was built in a small four section copper plated box that was obtained from a piece of surplus equipment. This type of construction is very rugged and provided optimum shielding. Standard VHF construction procedures were followed.

An unexpected problem arose in building the modulator. The General Electric PA-222 is just not meant for this type of construction, and one of the leads broke off. However, after some scraping and soldering, a connection was made to the broken lead. It is amazing how much abuse the IC took with no apparent damage. In future projects a printed circuit board should be used.

As a final step, the inside circuitry was painted with anti-fungus varnish made by GC Electronics. This is a reasonable precaution considering the outdoor use that this transmitter will be subject to. For the same reason, lock washers were used wherever necessary to insure mechanical dependability. The cover over the crystal and socket is an unusual feature. It is made of brass, and designed specially for this



Parts List

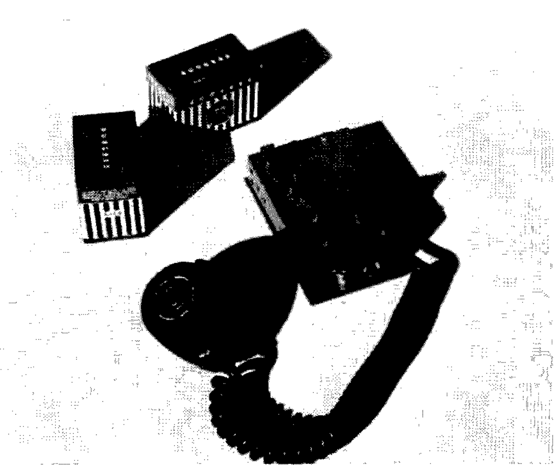
L1 .... six turns number 22 on 3/8 inch diameter slug tuned form
L2 .... two turns insulated hook-up wire on L1
L3, L4 .... ten turns number 18 3/8 inch diameter close wound
Xtal .... 50 MHz overtone type crystal
T1 .... Thordarson TR-21

Note:
R* is the value printed on the top of the PA-222. The tab on the PA 222 should be soldered to a suitable heat sink. Resistors are half watt except where noted. Capacitors are disc ceramic except for 1200 pF feedthrough capacitors and output tuning capacitor which is a piston trimmer.

use. Its manufacturer is unknown, but in a situation where one frequency is used, it was reasonable to protect the crystal even if it made frequency changing difficult.

Operation

The first problem that arose was in the oscillator coil. Some experimentation was required to insure easy starting and frequency stability under modulation. The circuit should be tuned to a higher frequency than where maximum output occurs. The final amplifier also had to be detuned slightly to obtain "upward" modulation. The slight reduction in power will not be noticed, but the distortion can seriously impair readability. It was also discovered that the large current swings in the modulator caused a serious voltage drop during modulation peaks. In order to eliminate this it was necessary to use separate power sources for the RF unit, making two batteries necessary.



Transistor transmitters tend to generate harmonics, and this one is no exception. For sporadic mobile and portable operation, the operator probably will not worry about this, but if operation is centered in a heavily populated permanent location, the operator may wish to check for harmonics. A harmonic does show on the GDO in the middle of the FM broadcast band, but no trouble has been reported. This is probably due to the lack of FM receivers in this locality, and the harmonic signal drops off within a few hundred feet of the transmitter. If problem do arise, standard TVI prevention methods ıould be employed.

Results

In an unscheduled test a mobile station was contacted. Before being told, he was unaware that the one watt transmitter was being used, and he thought it was the thirty watt base station transmitter.

Even with its relatively low power, this transmitter will provide a reliable high quality signal for the mountain-topper who likes to hike to those "hard-to-get-to" spots.

. . . WB6BIH

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Using FET's in Burst Generators

What's a burst generator good for you say? It's ideal for pulse testing of transistors at high peak power levels, pulse modulating transmitters on UHF or SHF or for other experimental work (or just for fun). **Fig. 1** shows an *rf* burst. V_1 is the sinusoidal "on" voltage and V_2 is the off (leakage) voltage. I call the ratio V_1:V_2, Rv (for voltage ratio). Ideally if the sine

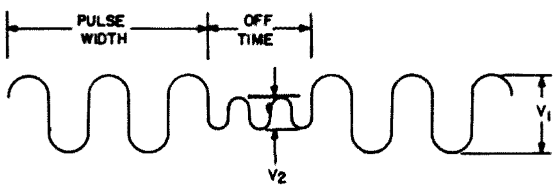


Fig. 1. V1 is the "on" voltage; V2 is the "off" (leakage) voltage.

wave were 100% modulated by the pulse, the leakage voltage (V_2) would be zero. Rv then equals infinity. But since a practical modulator cannot be perfect, there is some modulator output during the off time.

Immediately when I thought about a burst generator, I decided on the circuit of **Fig. 2.**

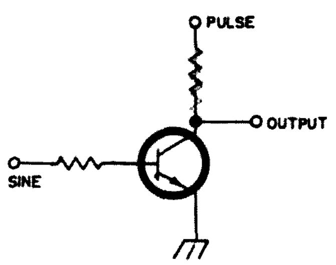


Fig. 2. The simplest and cheapest pulse modulator; however, there is a dc component in the output.

It is simple but has a drawback. It has a dc component in the output. That is, its output is like that of **Fig. 3.** To eliminate that problem let's switch to the circuit of **Fig. 4.** This circuit might seem reasonable at first glance (there would be no dc component in the output), but it fails for this

Fig. 3. Idealized output of circuit in Fig. 2.

reason. The collector-base junction of the transistor must be reverse biased for proper operation. This condition is not met (for instance, during the negative portion of the sine wave the collector is minus and the base is plus). Furthermore, because of the saturation voltage of the transistor, this circuit may not act as a very good switch anyway (neglecting the biasing). That is, suppose the sine wave voltage input is perhaps one-half volt, and the transistor saturation voltage is two-tenths of a volt. We loose a large percentage of our voltage across the transistor.

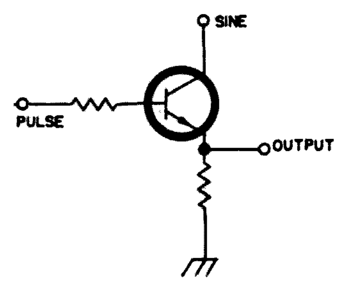


Fig. 4. This circuit is simple, but the transistor will not be biased for proper operation.

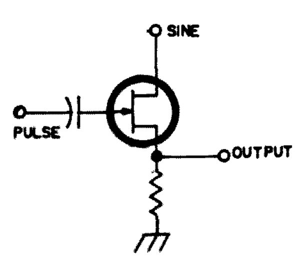


Fig. 5. Basic FET modulator.

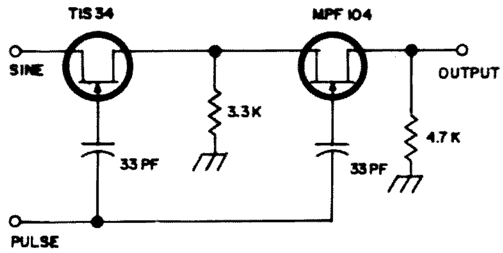
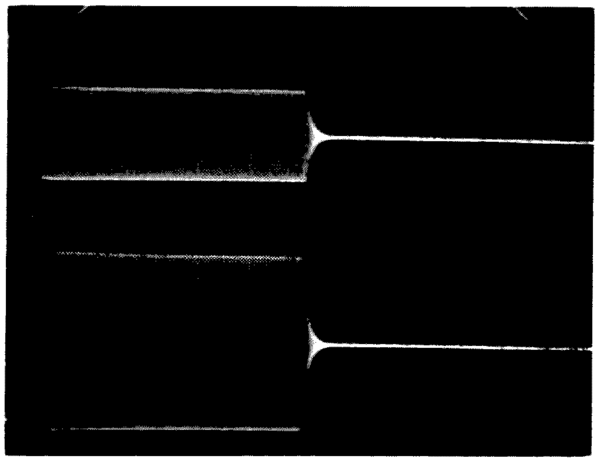


Fig. 6. Final burst generator design.



1 ms rf burst of 200 kHz (top trace) and after amplification (bottom trace).

At any rate, these problems can be completely eliminated by using a junction field effect transistor (JFET). The JFET measures many megohms between source and drain when cut off and the on resistance (channel resistance) on some of the good units runs only a few hundred ohms. The FET is now used as in **Fig. 5.** The Motorola MPF104 is excellent at $1.00, and the Texas Instrument TIS34 is equally good at $1.10. Both are available from Newark Electronics and several of the other large wholesale outfits. By using two burst generators in cascade I was able to get a higher modulation percentage (less leakage). Because of what I had at the time I used one Motorola unit and one TI unit. A pulse of ten to fifteen volts is required (remember to measure pulse height with an oscilloscope). To avoid damage to the transistors do not use excessive pulse voltage.

The circuit values may not be optimum for your application, so some experimentation may be in order. Even so, Rv for this circuit is excellent and typically runs 300 or 400. This setup can easily be used from ultrasonic frequencies up to ten mHz or so. Happy bursting! . . . K3VKC

TWO METER CONVERTER

for the Swan 250 or Anything Else

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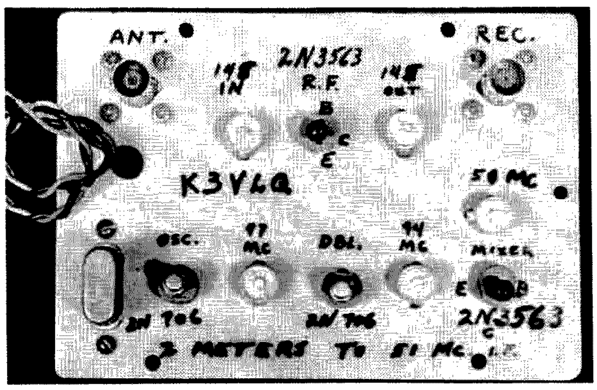
With the number of Swan 250's on the air, there are no doubt quite a few fellows who would like to plug in a converter ahead of theirs to see what's happening on the two meter band. With these fellows in mind, we put together this transistorized job.

For some, it may seem like a rather ambitious undertaking, considering the printed circuit board, but we tried to keep the difficult work to a minimum on the board, and, if it's your first etched board, it's a good project to start on.

A careful study of the underside of the board (foil side) will show that most of the foil remains, and only portions at the trimmer capacitors, the transistor sockets, and one long skinny U-shaped strip for the plus voltage were etched out. This leaves the rest of the foil for ground potential, and leads can be soldered up short, (a necessity at these frequencies).

A little trick we used on this board is worth passing on,—the matter of masking. Most manufacturers of cellophane tape are now making a rough or matte finish tape which can be written on with a pencil. Cover the copper side of the board with this tape, press it down tightly to be sure all the copper is covered, and lay out your work with a pencil. Using a razor blade or sharp knife, cut out the sections of tape *where you want the copper removed,* and lift off these sections of tape. Leave the rest on, because this is your "resist" for the acid.

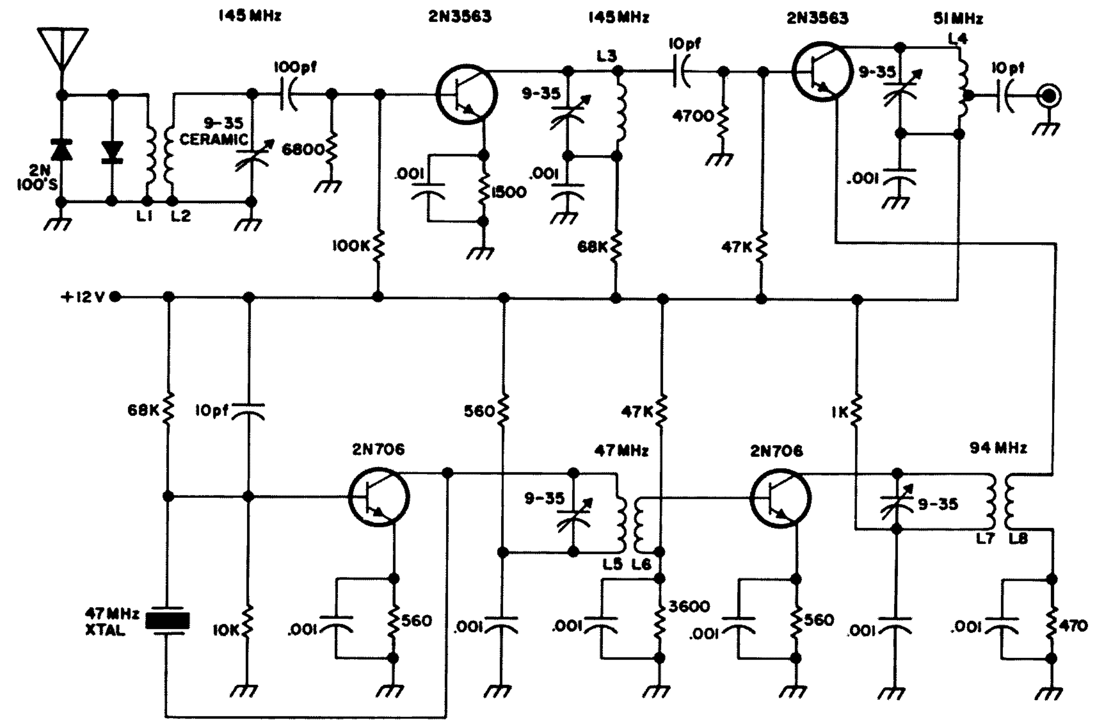
Drop the board in a ferric chloride solution for 45 minutes to an hour at room temperature, and you can watch the progress of the job. Use stainless steel, plastic or hard rubber tongs to handle the part in the acid.



When etching is completed, remove from the acid, flush in running water, and remove the masking tape. Look it over carefully with a magnifying glass, to make sure all the copper is removed where it should be. Any small portions you wish to take off now can be scraped off with a sharp knife or a razor blade.

The ferric chloride is a brown crystal that mixes easily with water. We use 1580 grams of crystals per gallon of water. You won't need much more than a pint in a glass, rubber or plastic tray. Use caution in handling this stuff as it leaves a brown stain that you won't get off a white shirt. The solution keeps well, and can be used over and over again until the etching time becomes too long. By the way, the etching process is accelerated by heating the solution to 160-180 degrees Fahrenheit, if you are in a hurry. If you try a printing shop that does photo-engraving, they may even give you some of the solution already mixed.

Printed circuit board stock is generally advertised in about a half dozen ads in the



back of this magazine. After you've etched a few boards like this, you'll wonder how you ever built anything without them. You can cut it with tin snips, heavy scissors, or a photo paper trimmer. Note the 1" high shield between the R. F. and the oscillator sections on the converter,—cut it, break it, bend it, and tack solder it in place,—cheap, quick and easy.

While we're talking about that shield, look below the "Ant." connector on the photo. Follow the dotted line to the "plus" lead, which is the long skinny U-shaped strip mentioned earlier. You will note that the bottom of the U passes under the shield. This portion of the shield is nibbled out to clear the "plus" lead, so that it won't short out, and doesn't show on the photo. Nibble out clearance with your diagonal cutters. You will also see a coupling capacitor going right through the shield at the bend. A small drill

Coil Data

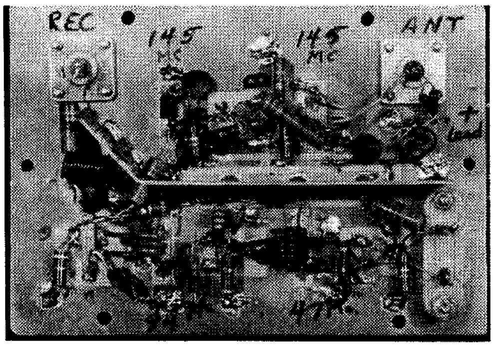
L_1— 3	turns	#26 insulated on L_2		
L_2— 6	"	#20 Air wound	3/16" dia. x	1/4" long
L_3— 7	"	" "	3/16" " x	5/16" long
L_4—13	"	" "	5/16" " x	1/2" long
L_5— 9	"	" "	5/16" " x	3/8" long
L_6— 4	"	#26 insulated on L_5		
L_7— 5	"	#20 Air wound	1/4" dia. x	1/4" long
L_8— 3	"	#26 insulated on L_7		

Coils L-2, 3, 4, 5, 7 all tuned to frequencies shown on schematic with 9-35 ceramic trimmer capacitors.

or pocket knife will cut that one for you.

Some experienced builders may question the labelling on the rf and mixer sockets, so an explanation is in order. Considerable experimenting was done on this prototype, with other transistors, including FET's and the leads may seem slightly scrambled. We didn't intend this to be a set of kit-building instructions and hope those who try to duplicate this converter will use a little judgment. The sockets were also used because we intended to do a little experimenting, and you can etch your board to solder your transistors in permanently, if you like, and save the price of the sockets. Since this was an experimental job, we left two of each type transistor in to show that they will work. If you prefer, use 2n3563's all the way through, or 2n706's all the way. Either type, or both are from Poly-Paks at four or five for a dollar. The crystal is also surplus, from JAN Crystals, and picked from their list of available frequencies for about a dollar. This one is for 47.0035 MHz. If you want to throw money around, order one for 47 MHz and it will cost you about $6.50. Personally, I can't see it. We might also urge you to buy a grid dip meter, if you don't already have one.

While on the subject of grid dippers, you will note that the trimmer capacitors are mounted so that they are accessible from the top of the converter, with the coils soldered directly to them on the other side



of the board. The coils were wound on the shanks of twist drills, and are self-supporting (see L-1 + L-2 near the "ant." connector in the photo).

The final tune up procedure used in developing this converter started with the 47 MHz oscillator. After you get it going, peak up the doubler, and remove power. Grid dip the rf and mixer coils, and it should take right off. A buddy on two meters is a big help, and once you get an on-the-air signal to peak up on, you've got it made.

We have a 500 kHz crystal calibrator in our Swan 250, and found the 145.06 MHz signal of a nearby Tech right where he was supposed to be the first time up. I guess we had the law of averages with us on that one.

For power, we use a home-brew supply, and can vary the voltage for maximum gain. Once set, voltage and trimmers need little attention. These transistors seem to work well in this configuration on anything from 3 volts to about 18 volts, and there we started to lose it. The 12 volt dc relay supply on the Swan Power supply should work fine, although we haven't tried it and can't guarantee it. A 9 volt transistor battery should let you hear something. Some day we might even stick a meter to this thing, just to see how much current it does draw! Anyhow, it works fine.

From past experience, we found that after publishing an article of this type, we usually get letters. We're more than happy to answer any and all, if we can, if you are having trouble. Just be sure you are having trouble that can't be answered with a little common sense, or a quick look at a reference manual. If you write, please include a stamped self-addressed envelope, and if we don't forget to answer too many, and can get a few evenings away, we plan to whomp out a heterodyne unit, to put the Swan on two-meters, sideband and AM.

. . . K3VLQ

"Q", "Q", Who Got "Q"

This nice article would have been more attractive if some of it had not been inadvertently omitted. If you are thinking about building this little instrument, turn to our October issue, page 82. First error appears in **Fig. 1.**

That can be corrected by drawing a line from the Xtal Osc. directly to the 100:1 Divider. Now the meter can look at the input **or** the output merely by turning the switch to left or right and without disturbing the operation of the circuit. This is the basic test of comparing excitation against response to determine Q.

And here are the parts not described in the schematic of **Fig. 2.** This will answer questions about transistor and diode types, and the values of CI, C2, and C3:

CI—Erie 557-000-39R, 5-25 pf.
C2—Centralab 858S-1000, 1000 pf.
C3—365 pf, see text.
C4—4-10 pf vernier, see text.
D1 & D2—1N97 type diode
R1—25K linear composition, Set Level, with switch.
R2—1K linear, Meter Zero.
L1—20 microH, Miller 41A225CB1
Q1—Fairchild SE2001 (2N3563)
Q2, Q3—Fairchild SE6002 (2N3566)
M—100 microA. meter.

Finally, the table of **Fig. 3** applies to a piece of #816 Airdux, 16 turns per inch, one inch diameter, leads one inch long.

This is cut to 34 turns and used to make up the test inductor shown. And now you can proceed with the test setup of **Fig.** 4 for Q calibration but a word of warning is in order.

That is, if you use surplus resistors be certain they are not wirewound construction, or film resistors corrected to value by cutting a spiral groove in the film. Either arrangement will be more inductive than the composition resistors Votipka used in his original work, and will bring you to misleading results. Good luck on this simple test instrument!

Cryptogram

T OUTANYAN ZXZORQYO WYZXS MZRM IF T ETNAZRYO WYZXS, TAS T OUTANYAN ETNAZRYO WYZXS NZAZQTRZM TA ZXZORQYO WYZXS.

(*Answer on page* 88)

VSWR-An Outmoded Parameter

As it is not possible to obtain a perfect match between a transmission line and an antenna, all the incident power cannot be transfered to the antenna, and that part which is not transferred is reflected along the line to the transmitter.

The better the match, the smaller the ratio of reflected power to incident power. This ratio can be measured with a reflectometer and is usually expressed in terms of voltage rather than power.

The voltage reflection coefficient is designated Γ (Gamma) and is given by:

$$\Gamma = \frac{\text{E reflected}}{\text{E Incident}} = \frac{[\text{Power Ref.}]}{[\text{Power Inc.}]}\frac{1}{2}$$

from which it is seen that the ratio of reflected power to incident power is given by Γ^2.

As Γ^2 provides an excellent criterion of the 'goodness of match' there is little further to be gained by making other measurements, but more of this later.

When power is reflected from an antenna, standing waves of voltage and current are set up on the transmission line and by measuring the ratio of maximum voltage at any point to the minimum voltage at a point one quarter wavelength away on either side, we get a parameter called the VSWR—voltage standing wave ratio. (The voltage ratio rather than the current ratio is measured because it is easier to measure voltage than current with the test equipment used).

It should be noted at this point that the absolute values of maximum or minimum voltages are in themselves quite meaningless and tell us nothing about the degree of mismatch. Like Γ, VSWR is a function of the degree of mismatch, and is related to Γ by

$$\text{VSWR} = \frac{1+\Gamma}{1-\Gamma} \text{ and } \Gamma = \frac{\text{VSWR} - 1}{\text{VSWR} + 1} \text{ so}$$

that each can be derived from the other.

Although VSWR can be measured with a higher degree of accuracy than Γ, it can only be measured directly by using slotted line techniques. Unfortunately this is only possible where the frequency is such that the portion of slotted waveguide used in measurements is at least about ten wavelengths long. This restricts the measurement of VSWR to microwave frequencies, where wavelengths are in the order of centimetres.

The reader, at this point, is no doubt asking the sixty-four-dollar question: How is it then that amateurs measure VSWR on amateur bands well below microwave frequencies?

The answer is—they don't! As mentioned previously, VSWR can be derived from Γ, and that is exactly what is done. VSWR meters used on the ham bands are simply forms of reflectometers with the meter calibrated in terms of VSWR and so we come to the next question: Why, after measuring Γ, do we go to the trouble of converting to VSWR?

Why, indeed?

Once Γ has been measured, we know all there is to know about the line/antenna match; going a step further and converting to VSWR tells us absolutely nothing more than we already know about the 'goodness of match'!

Let us assume that we are making some adjustments at the antenna end of a transmission line. The first adjustment gives a Γ of, say, 0.2. This means that $(0.2)^2 = 4\%$ of the incident power is being reflected. A second adjustment gives a Γ of 0.5 indicating that $(0.5)^2 = 25\%$ of incident power is reflected. In other words, an increase of Γ from 0.2 to 0.5, a factor of 2.5, increases the proportion of power reflected by a factor of $(2.5)^2 = 6.25$ i.e. from 4% to 25%. We can say that the second adjustment is 6.25 times worse than the first.

Now let us consider the foregoing in terms of VSWR.

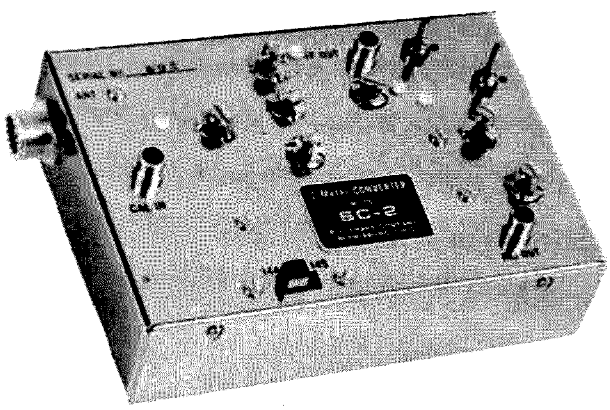
With a Γ of 0.2, VSWR $= 1+\Gamma/1-\Gamma=1.2/0.8=1.5:1$. A Γ of 0.5 gives a VSWR of $1.5/0.5=3:1$. Although the VSWR has doubled, the actual mismatch is 6.25 times worse.

From many conversations heard over the air, it is evident that most amateurs would assume that with a VSWR of 3:1, the ratio of reflected power to incident power is twice as great as that with a VSWR of 1.5:1, whereas, as we have seen, it is actually 6.25 times greater. In this writer's opinion, the time has come for amateurs to abandon the use of VSWR and to start using the much more informative and realistic Γ. Let us leave VSWR where it belongs—to the microwave bands.

Perhaps when this switch is made, we shall never again hear amateurs talking of VSWR's of 'less than one'! Sid Gould VE2AXQ

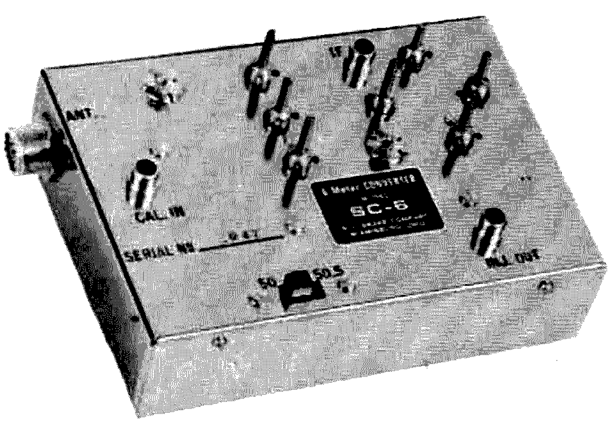
Drake VHF Converters

Kayla Bloom W1EMV
Dublin, N.H. 03444



Drake has entered the VHF market with one of the nicest packages I have ever seen. As usual, in recent Drake equipment, the design of the cabinet is beautiful. They have developed a new finish to their panels which makes it virtually impossible to scratch them.

The unit tested consists of the SC-6 and SC-2 converters, the CPS-1 power supply, and the SCC-1 VHF crystal calibrator, all housed in the CC-1 Converter Console. Each of the units may be purchased separately, but when put together in the console they make a complete VHF converter unit.



The console is designed for easy installation of the separate converters and power supply. The units plug in to the console cabinet so as to engage both the power plug and the on-off switch fork. At this time, only the units mentioned are available, but the console has room for a third converter which will be available in the near future.

Getting to the performance angle of the converters, I have been hearing signals which were unreadable in the past. Consistently, not just due to good conditions. Signals are good on 2 meters from New Jersey (350 miles away) and the Boston, Cape Cod area are S9 and better. This is covering a distance of 80 to 110 miles. There is an old saying in ham radio . . . "you can't work them if you can't hear them," but at this point it works the other way. I hear them, but can't work them.

I have to admit to having a better than average VHF location, being 1450′ above sea level, so it is all down hill, but my 2 meter beam is only 20′ above ground.

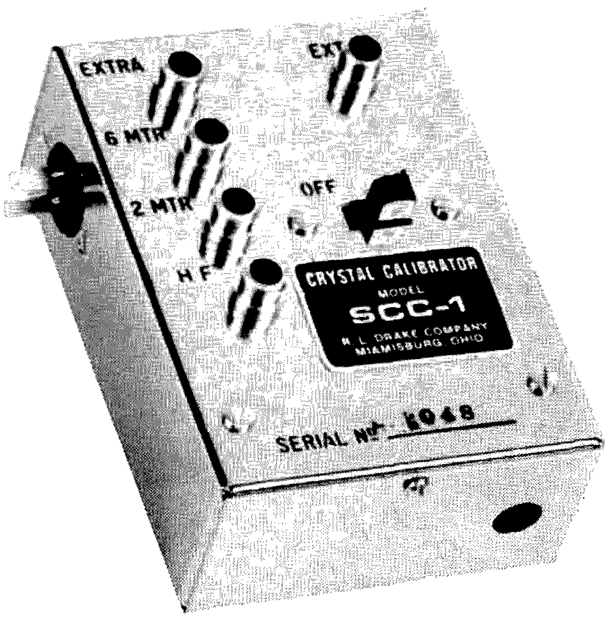
The two meter converter uses a TIS34 silicon, low noise FET in the front end. The mixer is also a TIS34 and follows a high pass filter to remove the mixer difference frequency.

The six meter model uses TIM12 germanium FETs. The noise level on 6 is higher than on 2, but this is to be expected and is certainly within tolerance for that band.

The *if* of both converters is 14 to 18 MHz and two crystals are provided for each unit giving fairly good coverage of each of the

bands. On 6 meters, 14.0-14.5 MHz gives coverage from 50.0-50.5 MHz with one crystal and 50.5-51.0 MHz with the other. On 2, coverage is 144-144.5 with one crystal and 145-145.5 MHz with the other.

For anyone wishing to change the factory alignment, the instruction manual gives fairly good details as well as a list of required equipment, but this can lead to sleepless nights, so unless you are prepared to spend a good deal of time, I would advise against making any changes. In the event you are brave enough to tackle realignment, and



make a bad job of it, Drake will realign it for five dollars plus postage.

The stability of both converters is superb. This is, of course partially dependent upon the stability of the receiver used. In my case, I used the Drake 2B. Interference from strong signals nearby are at a minimum and in some cases the selectivity is almost too sharp, especially on two meters. However, if you are interested in moonbounce or VHF DX work, this is a decided advantage.

The SCC-1 crystal calibrator is a jewel. It provides output for three converters and a separate receiver and gives accurate markings every 50 kHz to above 432 MHz. A trimmer is mounted in such a way that it is easily accessible, even when installed in the console cabinet. The oscillator is zener regulated and the circuit is a printed circuit with all parts easily accessible.

The CPS-1 power supply uses a full wave bridge rectifier mounted on a printed circuit board. The transformer has a fused primary and is mounted inside the case. The whole unit weighs only 17 ounces.

Both in performance, convenience, and good looks, this Drake package is tops.

. . . W1EMV

Reference reading

E. P. TILTON "A Featherweight Portable Station for 50 MHZ" QST NOV. 1964

D. DEMAW "50 MHZ One Watter" QST JUNE 1967

J. FISK "73 Useful Transistor Circuits" 73 MARCH 1967

DX TEST

OK, you DX'ers, let's put it on the line. Let's see just how good you are at beam directions. All you have to do is guess the beam direction for the following countries within five degrees. If you live in Minnesota make that three degrees because you have an advantage over everyone else because we want not just the headings of each of these countries, but the headings that you would use if you were in Minneapolis. That shouldn't be too hard, right?

Credit your self with five points for each right answer.

Israel	......	Bermuda	......
Togo	......	Singapore	......
Burma	......	Iran	......
French Somoliland	......	Nepal	......
		Galapagos	......
Ireland	......	Guam	......
Liechtenstein	......	Canal Zone	......
Egypt	......	Ascension Island	......
Heard Island	......		
Hawaii	......	Virgin Islands	......
Venzuela	......	Ceylon	......

Turn to page 88 and see how well you know your beam headings.

About "Load"ing . . .

Which Loads What - or - What Does It Mean?

Presumably we all know what we mean when we talk about loading a transmitter, or an antenna being a good load–but we often run into some confusion when we attempt to communicate what we mean to each other. Not a small part of the resulting difficulty and confusion is due to the little-known fact that the word "load" has a multiplicity of meanings, some of which contradict each other.

Most of us automatically say, in such a discussion, that we are "loading the antenna," or that "the antenna won't load." Unfortunately a few of us purists feel that an antenna in itself is incapable of "loading" anything–it merely furnishes the "load" for the transmitter.

Discussion between editor, publisher, and a staff member over this point in regard to the License Study Course series led to some research, which in turn led to the discovery (which surprised us all) that for once, everybody was right.

Our authority is Funk & Wagnalls Standard Dictionary of the English Language, International Edition, a two-volume work which is not quite so complete as Webster's Unabridged, but more comprehensive than most for its size.

We found that the word "load" is descended to us from old English, which was the language spoken in England before about 1150 A.D. and includes Anglo-Saxon. Like most four-letter words of Anglo-Saxon origin, it has about as many meanings as it has users.

Specifically, our dictionary lists nine separate meanings for it if used as a noun, and twelve more if it is used as a verb. Of the twelve "verb" meanings, nine are "transitive" and three are "intransitive." This means merely that nine of the verb meanings require an "object" while the other three do not.

None of the twenty-one meanings listed are precisely the usage of ham radio, but several of them are close enough to our usage to draw some conclusions from. The first meaning listed for "load" as a noun is: "That which is laid upon anything for conveyance," and that corresponds pretty closely to our purist feelings that the antenna is the "load" for the transmitter – that is, when we connect the feedline we are "laying the antenna upon the transmitter." The fifth meaning as a noun is also fairly close to this viewpoint: "the resistance overcome by a motor or engine in driving machinery."

Had we stopped right here, the purists would have won a clear-cut victory, and we would have been forced to conclude that those of us who say "the antenna won't load" are wrong. But we didn't stop; we went on to examine the verb definitions too.

The first definition listed for "load" as a verb is a transitive usage, meaning that something must be loaded by something else. The definition reads: "to put something on or into to be carried," and that is a pretty close fit to our usage when we say that a transmitter refuses to load the antenna. It would, however, outlaw the phrase "the antenna refuses to load the transmitter" because the antenna does not put anything into the transmitter to be carried.

We kept reading, and came to the sixth verb definition (also transitive) which says: "to take on (a load, cargo, etc.)." This one fits precisely with those of us who feel that the antenna loads; when we say that an antenna "refuses to load," we are saying that it "refuses to take on" power.

The real clincher to it all, though, was verb definition ten, which reads: "to take on or put on a load or cargo." This one is blatantly two-way, and permits us to say either "the transmitter refuses to load" (meaning "the transmitter refuses to put on the load") or "the antenna refuses to load" (meaning "the antenna refuses to take on the load") while citing the same authority for either usage!

So what does it all mean? Simply this: everybody is right, despite the possibilities for unlimited confusion. When, in a discussion of loading, it appears that everyone is talking at cross-purposes, the thing to do is to bring the discussion to a halting screech and get everybody together with the *same* set of meanings at least for the duration of the discussion. Then you'll be able to make some headway with the real problems of *why* there's a loading problem, without staying hung up in the somewhat artificial problem of what *loading* actually means.

73 Staff

Ø Cycle Audio Filter For CW

A Short Circuit

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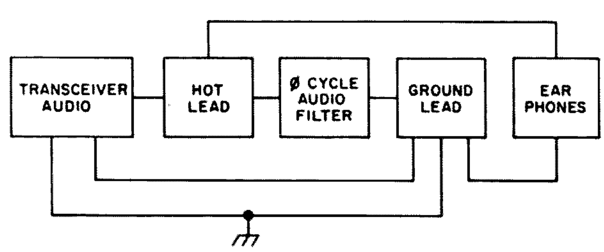
I am a bit of a CW addict, and at times my Galaxy leaves something to be desired, even with the 300 cycle filter turned on, in the way of selectivity. I felt I was really nitpicking if I was un-satisfied with such performance that I had achieved with no other work but signing the check. But such is striving for state of the art and I hoped to find some way of hearing only one signal and not many. With the BPD expedition in the offing, I felt that I should prepare myself for an even bigger onslaught of stations then I had to cope with when I was looking for WNV.

The narrowest filter I had seen advertised was a selectivity of 120 cycles. I of course had to try to beat this. So my goal was to be zero cycles selectivity, figuring that nothing could get through that in the way or QRM. All the filters I had seen were rather small in appearance. My own 300 cycle one was miniscule enough as was the 120 cycle one and a third that was advertised but I can't find at the moment. So along with outdoing the others in performance I had to outdo the others in size. This last wasn't hard to do for as every day passes there are more and more advances in microcircuitry, and all I had to do was use the advances that the others didn't have available when they were designing what turned out to be my competition. Lastly, if I could build it with parts I had on hand (read junkbox) then I could not only save money but also time in not having to go to the store for parts. Not really a requirement except in the most basic sense was the fact that I would need to be able to build a filter. Or I guess I should say figure out how to wire the parts together so they would achieve the desired resuit. I can use the term "design" now since it works but at the time I started I was "tinkering around with my stuff again." Working with audio, I didn't expect to have the problems I had when I tried to wire a six meter converter, though I am not putting down hi fi a bit. I guess I always will be a hay wire builder as well as I build. Well enough of this circut design parameter stuff and let me try to get into the theory of operation and then we will get down to the actual melting of solder which I call building.

Circuit Theory

After examining how the various audio filters worked I was impressed with the similarity of the circuits, as I am with transceiver circuits. Perhaps I am wrong but I felt if I was to achieve my hoped for performance of zero selectivity, then perhaps a different approach was called for. It seemed to me that maybe the maximum performance those circuts could produce had already been built and trying to achieve further narrowness was impossible. I think also secretly I wanted to do something different, cause I don't like to follow the crowd (except in DX) a prime reason why I was able to go through three years of the Army with a college degree and never rise above the rank of private. My mind settled on how best to eliminate all audio frequencies above zero. I was obsessed with the wonderful performance reports I had seen written up on Times Wire & Cable's new device which they called a "copper conducter." This had the remarkable fact that if it wasn't overloaded it would, at audio frequencies, shunt to ground all frequencies



Block diagram of Ø cycle filter installed in the audio system of receiver.

from zero to infinity, which seemed to meet my needs exactly. It turned out, upon experimenting with several prototypes in a breadboard circuit, that they were just exactly what I needed and my only problem was to choose the one I needed. This was quickly accomplished by choosing the smallest model that matched the audio power output (about 4 watts) of my transceiver.

Construction

I have always been a little bit annoyed with most construction articles, when they reached this point that they then said that if you couldn't follow a schematic then you weren't really a dyed in the wool constructor and they wouldn't tell you step by step how to build their pride and joy. I have been stopped many times from building what looked like a really good deal with just such an attitude of theirs. This is an excellent project for a beginner (my mother built one and her electronics goes only to operating the audio kill switch we have wired into the TV for commercials, and she got perfect performance in her model) as it doesn't take long to build and is very uncritical in wiring. I had the choice of wiring the modification into the receiver but that would mean lowering the resale value on the Galaxy on trade in time so that meant it had to be outboarded. The trouble with that though was that like the Galaxy filter it would be an extra box on the operating table and so at this stage I figured that if it could be wired into some other piece of equipment that wouldn't be traded, all the better. I finally settled upon the earphones themselves, since I had such small components to work with (thanks to microcircuitry) and large ears (thanks to genes). For a while I was going to modify both earpieces but decided against that, because of the extra work involved, so I make the modification in the earphone plug. The following step by step wiring diagram concerns that earphone plug modification, but the principle can be applied to just about any use.

1) Unscrew the plastic shell to the rear of the plug part of the plug.
2) Take a copper conductor and trim the leads to 1 1/8" when stretched straight.
3) Tin sparingly both leads of the copper conductor, use heat sink for protection. S2
4) Bend both leads so that they connect between the hot lead and the ground and make a good mechanical joint. NS
5) Place heat sink on lead extending from the copper conductor to the hot lead of the plug, apply soldering iron and solder. SI
6) Repeat step 5 for the remaining lead to the ground. SI

View of Ø Cycle Audio Filter installed in earphone plug. Note that the hot lead of the plug (top) is coupled to the ground lead of the plug via a Times Wire & Cable copper conductor. The plastic shell of the plug is to the left to show the wiring of the filter in the plug. The copper conductor and its leads are protected with a plastic covering. (VU2HG Photo)

Results

There, in six steps, are the secret to a whole change in CW operation. For me it has meant a whole new world, the complete absence of QRM; though with Gus set for take off in February (this is being typed 5 Dec.) I may still need something with even more selectivity. There is another advantage I think I have achieved with using a new circuit and components. That is, I have eliminated the annoying ring that comes with such narrow filters. The only trouble I have found now, seems to be receiver drift. Before, with 300 cycles, that was no problem but now with a 300% improvement in selectivity I find that I have to leave the transceiver on continuously and variac the line voltage to compensate for even one volt change in the line voltage. With my model 19, I find that I can copy on only one tone when they are on narrow shift and eliminate *all* errors, something that I haven't been able to do before on RTTY. Without a lot of fancy test equipment it is hard to say, but it is far better than anything I have ever read or heard about. The Galaxy filter has an audio amp to compensate for in-

sertion loss. This doesn't need one, so it apparently has no insertion loss. It is very convenient to use, for all I have to do for SSB is to unplug the headphone as usual and I am back at barndoor 2.1 kHz selectivity.

Finally, a note or two on construction hints (where I had trouble). I recommend that, for safety, the earphones be unplugged from the chassis as I attempted to wire the jack up without doing it and had a number of damaged copper conductors to show for the efforts. The other is to be certain of the polarity of the copper conductor so that the hot lead side goes to the hot lead side of the plug and the ground lead goes to the ground lead side of the plug. The two leads look the same, but are marked, so be sure to mark one lead with nail polish before taking it out of the box and risk getting them backwards. If you should get them mixed up, a simple resistance check with an ohm meter will straighten you out. As useful as these new copper conductors are, it won't be long before the price comes down and more people start manufacturing them. I expect to see a whole new series of articles in 73 using the devices that will come from what is now just in the embryo stages. . . . LX5SM/W4

Propagation Chart

APRIL 1969 J. H. Nelson

April 1969

SUN	MON	TUES	WED	THUR	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	$\boxed{26}$
27	28	29	30			

Legend: Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7	7	7	7	7	14	14	14	14
ARGENTINA	21	21	21	14	14	7a	21	21a	21a	21a	21a	21a
AUSTRALIA	21a	21	14	14	7b	7b	14	14	14	14	21	21a
CANAL ZONE	21	21	14	14	14	7a	14a	21	21	21a	21a	21a
ENGLAND	14	7	7	7	7	14	14	14	21	21	21	14
HAWAII	21a	21	14	14	7b	7b	14	14	21	21	21	21a
INDIA	14	14b	7b	7b	7b	7b	14	14	14	14	14	14
JAPAN	14a	14	14	7b	7b	7b	7	14	14	14	14	14
MEXICO	21a	14	14	14	7a	7a	14	21	21	21	21a	21a
PHILIPPINES	14	14	14	7b	7b	7b	7b	14	14	14	14	14
PUERTO RICO	14	14	14	7a	7	7	14	21	21	21	21	21
SOUTH AFRICA	14	14	7b	14	14	21	21	21a	28	28	21a	21
U. S. S. R.	7	7	7	7	7b	14	14	14	14	14a	14	14
WEST COAST	21a	21	14	14	7	7	14	14	21	21	21a	21a

CENTRAL UNITED STATES TO:

ALASKA	14	14a	14	14	7	7	7	7	14	14	14	14
ARGENTINA	21	21	14	14	14	7a	14	21	21a	21a	21a	21a
AUSTRALIA	21a	21a	21	14	14	14	14	14	14	14	21a	21a
CANAL ZONE	21a	21	14	14	14	14	14	21	21	21a	28	21a
ENGLAND	14	7	7	7	7	7b	14	14	14	14a	14a	14
HAWAII	21	21	14a	14	14	14	14	14	21	21a	21a	21a
INDIA	14	14	14b	7b	7b	7b	7b	14	14	14	14	14
JAPAN	14a	21	14	14	7b	7b	7	7a	14	14	14	14a
MEXICO	21	14	14	7	7	7	7a	14	14	14	21	21
PHILIPPINES	21	21	14	14	7b	7b	7b	14	14	14	14	14
PUERTO RICO	21a	14	14	14	7a	7a	14	21	21	21	21	21
SOUTH AFRICA	14	14	7b	7b	7b	14	14	21	21	21a	21a	21
U. S. S. R.	7b	7b	7	7	7b	7b	14	14	14	14	14	7b

WESTERN UNITED STATES TO:

ALASKA	14	14a	14	7a	7	7	7	7	14	14	14	14
ARGENTINA	21	21	14	14	14	7a	14	21	21a	21a	21a	21a
AUSTRALIA	28	28	21a	21	21	14	14	14	14	14	21a	28
CANAL ZONE	21a	21	14	14	14	14	14	21	21	21	21a	21a
ENGLAND	14	7b	7b	7	7	7b	7b	14	14	14	14a	14
HAWAII	28	28	21a	21	14	14	14	14	21	21a	21a	28
INDIA	14a	14a	14	14	7b	7b	7b	7b	14	14	14	14
JAPAN	21	21	21	14	14	7b	7	7	14	14	14	14a
MEXICO	21	21	14	14	7a	7a	7a	14	21	21	21a	21a
PHILIPPINES	21	21	21	14	14	7b	7b	7b	14	14	14	14a
PUERTO RICO	21a	21	14	14	14	7a	14	21	21	21	21a	21a
SOUTH AFRICA	14	14	7b	7b	7b	7b	7b	14	14	21	21	21
U. S. S. R.	7b	7b	7	7	7b	7b	7b	14	14	14	14	14b
EAST COAST	21a	21	14	14	7	7	14	14	21	21	21a	21a

Looking Back

Kayla, W1EMV

There seems to be a little Gremlin who plays havoc with articles and manages to build in errors. In some cases the errors originate with the author and the crew at 73, being overworked, lets them slip by. I guess the only way to have a magazine with absolutely no errors is to have more help, prepare each issue six months in advance and have 100 proof readers.

Here are some problems which have been called to our attention in recent issues.

August 1968, Pg. 70. A Review of the Newtronics 4-BTV.

Where reference is made to SWR at resonance, this is incorrectly printed as 1.5:1. It should be 1.05:1. The total height of the antenna is 23', not 33'.

October 1968, Pg. 30. High Performance Receiver for 2 Meters.

There are a couple of errors in the schematic on page 32. The primary center tap of T6 is not grounded. The resistor across L5 was shown with no value. This should be 47k. The oscillator tuning capacitor is shown as C4, but is called C1 in the text. Q5, which is numbered 2N385 on the diagram should be 2N3858.

November 1968, Pg. 20. IC Frequency Counter.

This article was oversimplified to a degree that most hams couldn't build it from the information supplied. We have since received voluminous material containing modifications, clarifications and corrections far too great to print for the limited number who will actually build this counter.

If you are seriously interested in building this counter, a SASE will bring you a copy of the additional material.

December 1968, Pg. 6. First Ham IC

In Fig. 4., page 8, there is no internal connection between the base of Q21 and collector of Q20. Since this article was printed, National Semiconductor Corp. has announced a lower cost version of the LM179/270. The new LM370 is now available through all NSC distributors.

January 1969, Pg. 28. Two Meter Transistor Transmitter.

The coil data was left out. Here it is:

L1- 18t # 24 el. ¼" slug tuned form, 2t sec. on coll. end
L2- 10t # 24 el. same as L1
L3- 6t # 18 bare ¼" dia.
L4- 2t same as L3
L5- same as L4
L6- 3t same as L5
L7- 4t same as L6
L8- 6t # 18 ½" dia. ct with 4t link
L9- Z235 with 6t removed
L10- 5t # 12 ½" dia. ct, 1t link

January 1969, Pg. 48. The Six Net.

Fig. 1. has several errors. In the lower left hand corner there should be a 500 pf capacitor in series with the crystal and the .01 capacitor which shunts the 560 ohm resistor. Without this capacitor, the oscillator will not oscillate. The 56k resistor at the base of TR2 does not go to ground. Rather, it should go to B-. The center tap of the output transformer does not connect to the junction of the two 10 ohm resistors. This creates a direct short. Instead, it goes to B-.

January 1969, Pg. 72. Quick and Easy QRP.

Figs. 1 & 2 were transposed in the text.

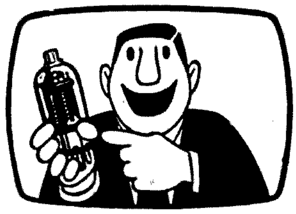
You can't win them all, but it would be nice to have a chance to win some of them.

Those Card Inserts

Several supposedly sophisticated readers wrote in to complain about the advertising card insert in the February issue. Perhaps they thought that I had suddenly changed and decided that I liked having cards stuck in 73. No, I hate it. But running a card like that makes it possible for us to print eight more pages of articles and this is hard to ignore.

If we charged you what it costs to put out 73, our subscription rate would be about $12 per year. The advertising in the magazine pays most of the freight and we are able to send you the magazine for three years for $12! Advertising is basic...the more ads the bigger the magazine...the fewer the ads the smaller the magazine. If you enjoy 73 and want to help, let our advertisers know that you appreciate their support of the magazine. And, let the advertisers who are not appearing in 73 know that you will support them if they support your favorite magazine.

— Wayne, W2NSD/1



NEW PRODUCTS

Pinpoint TV Troubles in 10 Minutes

If you are working with electronics gear this book is worth a few minutes of your time just to pick out the key ideas. And if you are in the TV service business it is probably worth much more than that to you. It explains and includes a carefully arranged, logical system for locating TV set faults.

The key point is that, for a given failure, some faults are more likely than others. An analysis of the observed symptoms will indicate certain circuits cannot be at fault, and that certain details might or must be out of line in some other circuits. For instance, if there is audio but no picture, you can scratch the low voltage supply and the front end circuits as sites for the trouble, and the high-voltage supply is worth early attention if a simple test indicates no picture tube voltage.

Pinpoint TV Troubles in 10 *Minutes is* TAB's book #428. It is available at your dealer's, or try TAB Books, Blue Ridge Summit, Pa. 17214.

New AF Generator

If your test gear uses vacuum tubes, it's out of date. Modern instruments using transistors and integrated circuits are more stable and reliable, use less power, and are very much smaller at no reduction in utility or accuracy.

A new audio generator has just appeared on the market. It meets or betters all specs for service type instruments. Imported from Japan by the DGP Company, it is probably going to revolutionize the whole test instrument market, which has not been very progressive lately.

About the size of a VOM, the generator weighs less than 2 lbs, and is about 7½" long, by 4" x 4". It has a calibrated vernier scale, and generates both sine and square waves (0.2 microsecond risetime!) over the range of 10 Hz to 100 kHz, at up to +9 dbm from a 600 ohm load. Amplitude and distortion specs are remarkably good, and the generator is useful anywhere 115-VAC is available.

The time is coming when a lab or service shop will have several little transistor and IC test gear boxes rather than shelf after shelf of big heavy contraptions for measurements applications. The early production runs of this generator are already sold but more are coming in, and are sure to be very popular in radio amateur applications. Price is $59.95.

Two Tips On Cutting Glass

Both of the following suggestions have been around for some time, but they do not seem to be general knowledge. In view of their usefulness, it would seem worthwhile to repeat them for the benefit of those who are not aware of them.

Chimneys for the 4 x 150 family of tubes are easily made by cutting off the tops of baby-food jars. To do the cutting painlessly, tie a heavy string around the jar about a ¼ inch below the point where you would like the break. Saturate the string with lighter fluid and set it afire. After the flame dies out, pick up the jar by the bottom, invert it, and plunge it quickly into cold water. The cut will be straight if the string was properly aligned and the jar vertical when it touched the water.

This works well on larger jars too. There are interesting possibilities in making chimneys for several of the larger types of tubes using peanut butter jars, etc.

Single strength sheet glass, such as is used in meters, dials, etc., is cut quite easily into odd shapes with tin snips or household shears. Fill a container, somewhat larger than the glass to be cut, with water. Immerse the glass and slowly cut out the desired shape. The glass must be entirely under water and the further the better. Be sure to wear gloves to protect your hands.

I know both of these ideas sound slightly unreasonable, but they work beautifully.

William P. Turner, WAØABI

BX Sheath is Handy!

The metal sheath used to enclose wires in BX electrical cable has many uses in the hamshack. The sheath can be used to cover several wires at a time. For example, a single BX sheath will enclose the coax and rotator cable leaving your shack for the tower. This reduces XYL resistance immensely! You can use BX sheath behind the operating bench to untangle the "wire jungle." As a bonus, the sheath looks really "professional."

You can get BX sheath at construction projects or from your electrical contractor. True, the lengths will not be more than a few feet long, but even this is enough to reduce a lot of "jungle" into only several cables. For long lengths of sheath, you will have to buy some BX cable and remove the wires inside.

You will be pleasantly surprised at how much neater your shack is when you use BX sheath!

D. E. Hausman, VE3BUE

(...de W2NSD/1 continued from page 2)

ate from if he is going to keep those dollars rolling in. This is where trouble has arisen in the past...once you are out on a small island somewhere who is to know where you really are? Or if you are sitting in some west African country who is to know for sure which one you are really operating from? It is a lot easier to sit back and drink a beer or coke for a couple of days and then come back on with a new call from a nearby country and save all the wear and tear on yourself.

Perhaps the new restrictions for DXCC will prevent this from happening again. I doubt it. When money is involved people find a way to get around just about anything. We've already seen false statements by ship captains in the recent past. It is possible that the ARRL will continue to accept fake DXpeditions rather than chance the members' anger by discounting them. I believe that they have enough evidence to write off some forty to fifty not too long past DX operations. I guess I don't blame them for choosing to hope that it will all blow over. Did you suspect that there might have been that many crooked operations in the last few years? Well, *you* paid for them. You keep donating money the way you have and you'll probably get more of the same. ... *Wayne*

CLUB SECRETARIES NOTE

Your club can round up some extra funds by imploring, cajoling, convincing, or forcing your members to subscribe to 73 Magazine. Never mind the cries of anguish, just remember that you are doing what is best for them—and the club.

Subscriptions to 73 are normally $6 per year. The special club rate is exactly the same: $6. The only difference is that the club treasury holds 25% of the loot and sends the rest to 73. Send us $4.50 for each one year subscription, in groups of at least five subs. Just think, if your club has 10,000 members you can quickly get $15,000 for the club on this deal!

Send the subscriptions to us on 3"x5" cards, giving the name, call, address, city, state and zip code of each subscriber. If the subscription is a renewal please include the address label from a recent 73 wrapper. Indicate all renewal subscriptions so we won't start a second sub. We have been known to do that.

Send to: Club Finagle, 73 Mag. PETERBOROUGH, N.H. 03458

Camp Albert Butler

Dorothy C. Saunders, W4UF
P. O. Box 295
Englewood, Florida 33533

For the ninth consecutive year, this past August saw men and women, and boys and girls, from all over the country arriving at Camp Albert Butler in the Blue Ridge Mountains of N.C. for its annual radio school. By plane, bus, and car they came, from all backgrounds and businesses, and ranging in age from 12 to 80.

This radio school, the only one of its kind in the country, is under the direction of Carl L. Peters, K4DNJ, General Secretary of the Gilvin Roth Y.M.C.A. in Elkin, N.C. It offers a maximum number of 60 students the chance to take a two-weeks' highly concentrated course leading to either the General, Advanced or Extra class of amateur radio license. On the last day an F.C.C. Examiner gives the students their examinations. Radio theory and code are taught in alternate courses during all of each morning, and again in the evening after dinner. Afternoons are free for study, code practice, swimming in the large outdoor pool, rifle, archery or pingpong. A number of field trips are also arranged during the two weeks to places of interest in the vicinity.

The camp is perched in a flat clearing on the top of one of the Blue Ridge Mountains, just two miles south of the Parkway, at about 3600' in altitude, with a striking view out over the great monadnock called Stone Mt., and miles of the rolling piedmont below. Rustic cottages are scattered among the large trees and rhododendrons, with the dining hall at one end of the swimming pool, and a very large recreation hall at the other. A camp radio station is in active use on several bands, as well as the sets brought by students, for skeds with home and other contacts during the session.

This was my second year as an instructor at the radio school and I had one of the mixed adult-teenager groups in radio theory, and the fastest code speed group, both leading to the general class of license. The general class students are divided into three theory and three code groups. On the first night of camp a code test is given to everyone, and separations into the code classes are made upon their ability to copy at around 5 wpm, or 8-9 wpm, or 12-13 wpm. The advanced and extra classes of students are together for both theory and code, with one instructor.

They worked hard to get their speed up to 13 wpm for their general class ticket, and to understand the intricacies of Ohm's law, and other problems of theory. For the adults, the financial successes of their past lives helped not a bit at the camp, where the only

criterion of success was whether or not one had passed the last theory test, or could as yet copy 65 consecutive letters without a mistake. The M.D.'s, judge, trial lawyer, retired executive vice president of one of the largest national food chains, priest, oil-well driller, oil-well owners, electronic components manufacturer, ex-h.s. principal, nurse, test driver for General Motors, policeman, engineers, and teenage grammar and high school students, among others, all studied and helped each other to understand difficult points, in a wonderful example of *esprit de corps* and friendship. One group of students, who might perhaps more correctly be dubbed "the young at heart" than "the young in years", were put together to live in one of the large cabins, which they promptly named "The Pill Box." They got along so famously that plans have been made to get together on a "Pill Box Net" as soon as they receive their licenses.

Highly motivated and bright as the teenagers are, it is a stimulating experience to teach them. It truly would be a revelation to some of their former teachers, I am sure, to see how hard they work. The teens are definitely the age when it is the easiest to learn code, as many an older student at camp ruefully realized when he struggled to copy 65 letters at around 13 wpm, and found next to him a 14-year-old breezing along with no effort and 100% correct copy. During the last several days of camp, the highest code classes for the General group are at 15 wpm, so that up to two minutes of speed may be lost through tension during the F.C.C. exam. Parents whose teenagers become interested enough in ham radio to want to study and get their general licenses, are indeed fortunate. There will be no delinquency problems in their homes, but instead fascinated youngsters at their little transmitters, learning to communicate with others of like interests elsewhere in the world, and slowly increasing their technical knowledge.

Once again this year on the morning of the last day of school, after a hearty and excellent breakfast, the instructors watched the long line of cars wind down the mountainside on its way to Elkin where the F.C.C. examinations were given.

Now little notes are being received by the instructors from their students, proudly giving their new calls and asking for skeds. And a new group of graduates of Camp Albert Butler is launched upon the amateur bands.

...W4UF

Getting Your Extra Class License

Part III Television and Interference

Staff

One of the most catastrophic factors ever to hit amateur radio was the advent, some 25 years ago, of television.

Old-timers may remember their problems with broadcast interference--but they were virtually insignificant when compared to the problems posed by TVI. Television interference just would not be tolerated by the public--and not a few incidents of violence such as toppling of antenna towers and pot-shots at the ham shcaks were recorded in the beginning.

Understandably, the FCC has rather strong feelings also about interference between the various services licensed by it, and so all examinations for Amateur licenses include some questions on television interference and its control. As the highest of all ham tickets, the Extra Class requires not only a knowledge of TVI control but also a knowledge of television techniques themselves.

We had originally intended to cover both TV and VHF in this installment of the Extra Class Study course, but it became obvious that if we combined the two we could do justice to neither. This month, then, we'll cover only three of the FCC study questions--those dealing with television. Next time, we'll move on to take our scheduled look at VHF.

This month's questions (the numbers, as always, are from the FCC list in case you're following it) are:

8. How does amateur TVI usually affect television reception?

34. Why are synchronizing pulses transmitted with television signals?

54. How can unwanted VHF resonances in a transmitter amplifier be moved from TV channel frequencies?

Following our usual practice in order to provide more comprehensive background, we'll rephrase these three questions into others.

All three require some knowledge of the actual transmission techniques used in television. Our first question, then, will be most broad--"What is Television?" From this beginning, let's find out "How Is Television Transmitted?" for the answers to the big problem, "How Is TVI Suppressed?"

Even if you're not interested in the Extra Class ticket, you may find this particular installment worth leafing through. While we'll be concentrating on the theory behind the practice, as we always do in this study course we'll also be touching on some most practical "how-to-do-it" points along the way.

Ready? Let's dive in!

What is Television? Some of you may find this question's implications insultingly simple --and others may find it to be far too complex. Lewis Carroll once wrote (if it wasn't he, it should have been): "The place to start anything is at the beginning", though, and that's why we're here.

Television is, of course, the picture on the boob tube; these days, as likely as not it's in glorious color. That's not really the answer we're looking for. What we actually want to know is, "How does it get there?"

Without going into the mechanism of the cameras at all--let's assume for now that they're working as intended--the picture gets on the face of the tube because it's *wiped* there by a speeding electron beam which actually *is* faster than a bullet.

This tiny beam is pulled across the face of the tube from left to right exactly 15,750 times every second, and at the same time it's pulled down the tube face from top to bottom so that it takes 1/60 second to make the vertical trip. During this single pass it covers the complete face of the tube, and draws 262-½ almost-horizontal lines as it goes. The beam then flies to the top of the tube--moving halfway across the tube face as it does so, so that the next pass begins in the middle of the horizontal line and draws another 262-½ lines. The timing is such that the lines almost but not quite overlap each other, so that a total of 525 lines are drawn every 1/30 second.

All the time that this little spot is moving on the tube face, its intensity is being changed

–and these changes in intensity are what put the picture on the screen.

In this entire process, everything happens with extreme speed. The beam must move the width of the screen in 1/15, 750th of a second, which on a "20-inch" tube works out to a horizontal motion of something like 14,000 miles per hour. The intensity must change in much less time than this, to reproduce the fine detail we're used to seeing. In fact, the intensity must be capable of changing in less than 250 *billionths* of a second in order for the signal to meet present federal standards.

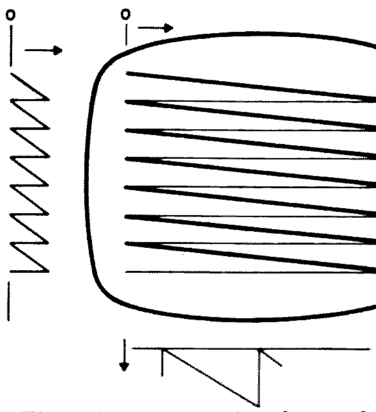


Fig. 1--The picture on the face of a TV tube is produced by the process shown here. A single electron beam is swept horizontally across the screen from left to right 15,750 times per second, and at the same time vertically from top to bottom 60 times per second. As it moves, its intensity is varried to produce the entire screen.

Fig. 1 illustrates the process we've been examining and shows how the electron beam paints the pattern of lines on which the picture appears. One complete pass of 525 lines is called a "frame", and the actual line pattern produced on the screen is known as a "raster".

At this stage, we still don't have a very clear image of how the picture gets on the tube–but we know that in order to get a picture there, we must control three items. These are: (1) the horizontal position of an electron beam, (2) the vertical position of that same beam, and (3) the beam's intensity.

The horizontal and vertical positioning of the beam in any TV receiver is done by "sweep circuits" which produce sawtooth waveforms at the appropriate frequencies. These waveforms are also shown in Fig. 1. The horizontal sweep waveform occurs 15,750 times per second, and the vertical waveform runs at a 60-per-second rate.

Both of these sweep signals are produced by free-running relaxation oscillators in order to generate as even motion as possible for the beam. Relaxation oscillators are notorious for frequency drift but are very easy to stabilize by locking or "synchronizing" them to some reference signal. The necessary reference signals in TV are the "sync pulses" which are transmitted as a part of the composite video signal; they yank the oscillators into step at the beginning of every sweep cycle. We'll get into this more a little later.

Intensity of the electron beam is controlled by varying the bias between grid and cathode of the picture tube; this bias is controlled by a wide-band ac signal known as the "video" signal. When bias is large (cathode positive or grid negative) the electron beam is weak and the screen is dark. When bias is less, the beam is stronger and the screen is brighter.

This action is identical with the amplification action of an ordinary audio amplifier tube, in which the audio signal controls grid bias and so changes the flow of plate current. The major difference is that in the TV picture tube the beam current is directly related to screen brightness and we don't have to have anything like a loudspeaker to convert current to sound or light. The only other significant difference is that the picture tube must handle a signal of much higher frequency than does an audio amplifier, since brightness in the picture may change several million times per second as the beam wipes across the scene.

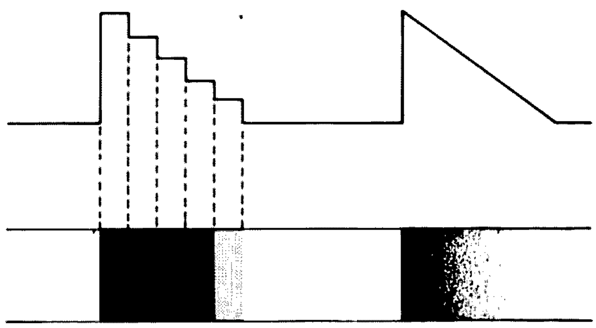


Fig. 2--This illustrates the relationship between the grid-cathode bias in the picture tube (upper waveforms) and the corresponding screen brightness on the tube's face (lower line). The greater the bias, the darker the screen. FCC regulations prescribe that the brightest part of an image must produce the lowest video voltage output, which cannot be less than 1/8 the maximum signal level, and that the darkest part of the image produce the maximum video level, which cannot be more than ¾ the maximum level. The portion of the signal above "black" level is used for blanking and sync pulses.

Fig. 2 shows the relation between picture-tube bias (or signal voltage on grid or cathode) and screen brightness. The upper line represents cathode voltage while the shaded band

represents screen brightness. The more positive the cathode, the darker the screen. As you can see, the signal may change either in stair-step fashion (left of figure) or continuously (right). The stair-step changes produce sudden changes of brightness while the continuous changes produce gradual shading effects. A typical picture will have both kinds of changes in it.

The TV camera also operates with a sweeping electron beam, which does the original translation of the picture into a varying electrical signal. For this varying-level signal to reproduce a recognizable image at the receiver, the receiver's sweep circuits must be locked exactly to those of the camera. This is the primary reason why the sync pulses are included in the composite video signal.

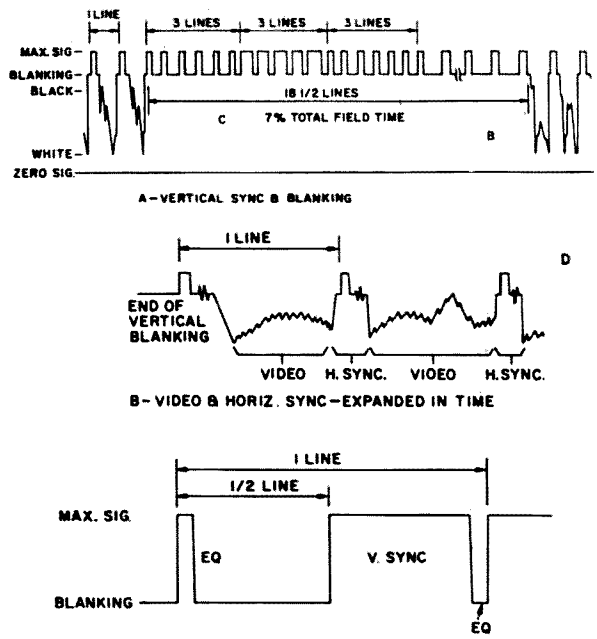
We've talked about the "composite video" signal several times now without explaining it at all. It's not the same as the "video" signal. The "video" signal consists *only* of the voltage changes representing brightness variations. In commercial broadcast TV, bandwidth of the video signal is set at 4.5 MHz; in industrial and closed-circuit TV, bandwidths as high as 6 MHz are frequent. The low-frequency limit on this signal is only a few cycles per second; it must be able to hold the screen dark for several frames at a time. In fact, for highest quality, this signal should extend all the way down to dc at the low end–but for economy's sake, it seldom does.

To keep the video signal from the camera in step with the receiver's sweep circuits. sync pulses in both the horizontal and vertical directions are necessary. When these pulses are combined with the video signal, the result is the composite video signal. **Fig. 3** shows the waveforms involved in a black-and white broadcast TV composite video signal.

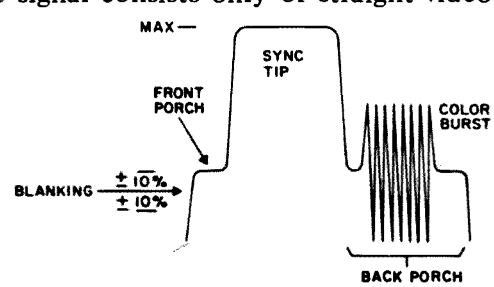
Before we examine **Fig. 3** in any detail, let's move on a little bit and look at color. Color TV is almost exactly like black-and-white so far as the transmitted signals are concerned, although the actual equipment and circuits are far more complex for color.

The big difference with color is that we must control a fourth factor in addition to the two positioning signals and the beam intensity (which is known as the "luminance" signal in color TV). This fourth factor is the signal which determines the exact color mix produced by the beam at any one position, and it's called the "chrominance" signal.

We won't go into much detail about the chrominance signal except to say that it's carried on a phase-modulated subcarrier signal. The only reason for looking at it at all, at this point, is because in a color TV composite video signal we have all the elements of the black-and-white signal–*plus* an 8-cycle "reference burst" to let us work with the chrominance signal. This reference burst is also shown in **Fig. 3**. It is transmitted *only* in a color signal, and is not present when black-and-white is being transmitted.



Now, let's look at **Fig. 3** in detail. You can see that four separate views are necessary to show the complete makeup of the composite video signal. The most general, view A, shows the vertical sync pulse and "vertical blanking interval". This set of waveforms shows up 60 times every second; the rest of the time the signal consists only of straight video over-



D–H. SYNC DETAIL

Fig. 3--These four views at different degrees of expansion in both time and signal amplitude show the details of the synchronization pulses, equalizing pulses, and color burst on the FCC standard television signals. View A shows the major portion of the vertical blanking interval while views B and C expand portions of view A. View D details the tops of the horizontal sync pulses to show front and back porches and the color burst. Color burst is omitted from B&W telecasts.

laid with the horizontal sync pulses as shown on either side of the vertical blanking interval in view A.

As view A shows, the vertical blanking interval takes up 7/100 of the time for each complete field (a field is 262-½ lines, or half of a frame) and occupies the same time as 18-½ lines. In TV, incidentally, it turns out to be convenient to refer to time in terms of "lines" since the duration of one line is a key time, to which everything else in the signal must be related.

Of the 18-½ lines occupied by the vertical blanking interval, only 3 lines are occupied by sync pulses themselves. Six "equalizing pulses" occur on either side of the vertical sync pulses, and the spaces between vertical sync pulses are also employed as equalizing pulses. During this time, no horizontal sync signals are present and the equalizing pulses are used instead.

The other important point contained in view A is that all of the sync information is transmitted at a level higher than the blackest black in the picture, which in turn is higher than any lighter shades. The technician's term for this is to say that sync is "blacker than black". Maximum and minimum levels for each part of the composite signal, with reference to the maximum radiated level, are set by FCC regulations. The blackest part of the picture cannot produce a level higher than 95 percent of the "blanking level", and the blanking level itself cannot be higher than 85 percent of the maximum signal.

As a result of these restrictions, the transmitted picture is enclosed in a blacker-than-black frame produced at either side by the horizontal blanking and at top and bottom by the vertical blanking interval. More important to the viewer, the sweeping electron beam flies back across the picture during these times. Having its intensity turned all the way off makes circuitry much simpler.

You can see these signals on any TV set, incidentally. All you need do is turn the brightness up and contrast down so that "black" becomes a middle gray, and carefully adjust the vertical hold control until a black bar rolls slowly down the screen. In the center of this dark bar you will be able to see a darker area with a shape in the middle faintly resembling the head of a sledgehammer.

If you are steady enough of hand to adjust the dark bar to a stationary position in mid-screen, you can count the lines in it. You will find that the darker area in the center is composed of the vertical sync pulses, with 3

lines above it and 12-1/2 below. You may count 6 and 25 respectively, if your set is in excellent adjustment, due to the interlacing of successive fields into frames.

View A in **Fig. 3.** also indicates the parts of the signal to which views **B** and **C** apply.

View **B** shows two lines of video immediately after the vertical blanking interval, and their two associated horizontal sync pulses.

View **C** shows the relationship between equalizing pulses and vertical sync pulses. The equalizing pulses keep the horizontal sweep in sync during vertical-sync times, and also permit the half and half interlace since they occur twice as often as horizontal sync pulses.

View **D** shows the top of a horizontal sync pulse. The part which protrudes upward is known as a "sync tip" and performs the actual synchronization. The part which is at blanking level immediately preceding the sync tip is called the "front porch" while that immediately after the sync tip is the "back porch".

Also shown in View **D** is the color reference burst, which occurs on the back porch if it is present. This signal, which is absent in black-and-white signals, consists of at least eight full cycles of a 3,579,545 Hz sine wave, accurate in frequency to within 10 Hz. This signal is produced at the transmitter by a continuously-running oscillator and is keyed into the composite video without any change of phase. Its modulation limits are approximately equal to the height of the sync tips.

Now that we know more than we really wanted to about the nature of the composite video signal, we can see how it is used in a TV receiver.

The entire signal is received by the front end just like any other VHF signal, and goes through mixing and the *if* strip. An ordinary diode detector then recovers the composite video from the *if* amplifier output. The composite video is then amplified to a level adequate to swing the picture-tube beam from full on to full off.

The sync signals are applied to the picture tube also, where they blank off any output during retrace times. At the output of the video amplifier, they are also picked off by a sync separator circuit which is essentially a pair of low-pass filters. One filters out everything but the relatively low-frequency vertical pulses while the other takes out the video but lets both horizontal and vertical sync remain.

The signal containing both horizontal and vertical sync is then passed through a clipper which lets *only* the sync tips through, so that nothing comes out from the vertical pulses while one blip emerges for each horizontal pulse that comes in.

The resulting vertical and horizontal sync pulses are then applied to the sweep circuits where they lock the oscillators in step with the transmitted signal. Each sweep circuit contains amplifiers which drive the yoke and deflect the electron beam. The horizontal output circuit also is used to develop the high voltage for the picture tube, since horizontal sweep is always present.

As the sweep circuits wipe the beam across the face of the picture tube, the video signal varies its intensity, and the result is a reproduction in light and darkness of the image being viewed by the camera.

Strictly speaking, this answers our original question "What Is TV?"–at least in an oversimplified version. But all that we have looked at so far is the sending and reception of the video information. When most of us think of TV, we think of the whole thing–both picture and sound and maybe even the color.

We don't go into the mechanics of color very far, because it's full of abstruse mathematics. Commercial TV, though, we can explore in more practical detail. In fact, we must if we are going to use our results in battling TVI!

Even at this state, it's fairly easy to see that any ham signal which gets mixed into the broadcast video signal is going to be displayed on the TV screen as a pattern of light and shadow. The exact pattern displayed will depend upon the ham signal itself, since the unimaginative receiver can't tell the difference between one of our AM voice signals and the also-AM video signal it's designed to receive and display.

But the composite video signal is not the only one present in a TV channel. We've already made in passing the acquaintance of the "chrominance" subcarrier–which just happens to lie in the 75-meter phone band, and *can* get clobbered in some cases by a ham signal. The result is wild to see–the picture is fine except that all the colors are wrong, and they shift with the modulation of the interfering signal. Lovers of the psychedelic should view it sometime; they might find it more entrancing than acid.

Also present in each channel, though, is an audio carrier. Audio in this country is FM, and so hams seldom interfere with it. *Fig. 4* shows

the various signals within a TV channel, their frequencies with respect to the low-frequency end of the channel, and the relative strength of their outputs.

In this country, VHF TV is broadcast on 12 channels numbered 2 through 13, and UHF TV occupies the 70 channels from 14 through 83. The VHF group is divided into "low band" and "high band" regions. Low band runs from 54 to 88 Mc, with a 4-MHz hole between 72 and 76 MHz (between channels 4 and 5); high band runs from 174 to 216 MHz continuously. *Fig. 5* lists the 82 channels and their frequency limits. To determine the exact frequency of any specific TV signal you can use *Fig. 4* and *5.* together *Fig. 5* provides the channel limits, while *Fig. 4* shows the position of each signal within the channel.

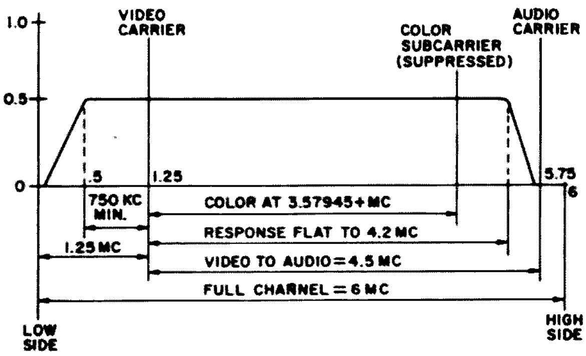


Fig. 4--Arrangement of signals within each of the 82 commercial and educational TV broadcast channels is as shown here. The video carrier, located 1.25 MHz above the low limit of the channel, is the reference for all other signals. The audio carrien is exactly 4.5 MHz higher, and the color subcarrier if present is 3.579545+ MHz above the video. Response must be flat from 750 kHz below the video carrier to 4.2 MHz above, and taper off rapidly beyond these limits to zero at the low channel edge and at the audio carrier. Limiting frequencies for each of the channels are tabulated in Figure 5.

In some cases, signals within a channel may be offset by 10 kHz either side of those shown in *Fig. 4.* If an offset is present for any TV transmitter,it will be the same amount and in the same direction for all signals from that transmitter. The purpose of this offset is to reduce co-channel interference between two stations assigned the same channel; with one of them offset 10 kHz high and the other offset 10 kHz low, their signals will always be 20 kHz apart--and this is enough to reduce interference significantly.

Broadcast TV modulates the video carrier with AM, using a technique called "vestigial sideband". This is partway between ordinary AM and SSB--but the carrier is not suppressed. All of one sideband is transmitted, but only

CHANNEL	BAND	CHANNEL	BAND	CHANNEL	BAND
2	54-60	29	560-566	57	728-734
3	60-66	30	566-572	58	734-740
4	66-72	31	572-578	59	740-746
5	76-82	32	578-584	60	746-752
6	82-88	33	584-590	61	752-758
———	———	34	590-596	62	758-764
7	174-180	35	596-602	63	764-770
8	180-186	36	602-608	64	770-776
9	186-192	37	608-614	65	776-782
10	192-198	38	614-620	66	782-788
11	198-204	39	620-626	67	788-794
12	204-210	40	626-632	68	794-800
13	210-216	41	632-638	69	800-806
———	———	42	638-644	70	806-812
14	470-476	43	644-650	71	812-818
15	476-482	44	650-656	72	818-824
16	482-488	45	656-662	73	824-830
17	488-494	46	662-668	74	830-836
18	494-500	47	668-674	75	836-842
19	500-506	48	674-680	76	842-848
20	506-512	49	680-686	77	848-854
21	512-518	50	686-692	78	854-860
22	518-524	51	692-698	79	860-866
23	524-530	52	698-704	80	866-872
24	530-536	53	704-710	81	872-878
25	536-542	54	710-716	82	878-884
26	542-548	55	716-722	83	884-890
27	548-554	56	722-728	———	———
28	554-560				

Figure 5--Broadcast TV channel limits in MHz. Horizontal lines separate listing into low-band VHF, high-band VHF, and UHF channels. See Figure 4 for exact frequencies of various signals within channel.

a part of the lower sideband is sent. This is the portion closest to the carrier, which is carrying the low-frequency components of the video signal.

Any other signal near the video carrier may beat with it to produce sidebands within the video-sideband range. The effect on the screen ranges from horizontal black bars, if the beat frequency is low, to a grainy cross-hatched appearance if the beat frequency is higher than the horizontal sweep frequency of 15.75 kHz. If the interfering signal is also AM, its modulation will also interfere; this always produces the horizontal-bar effect since the modulating frequencies for speech are below 15 kHz. These bars flicker with the modulation, and are usually called "modulation bars" or "sound bars". They may be produced in the TV receiver even without interference, by mistuning the set so that the FM audio is slope-detected in the video circuits and applied to the picture tube.

If the interfering signal is FM, its modulation will not usually be apparent on the screen. The usual result of FM interference is a shifting cross-hatch pattern, which moves with the modulation. This is much less annoying to viewers than are the big black bars--which is one of the major arguments in favor of FM for VHF operation in metropolitan areas.

But we're getting ahead of our questions Now that we have an admittedly oversimplified idea of the basic principles of TV as used in this country today, let's move on.

How Is Television Transmitted?

We've already met the various components of the transmitted TV signal--the video, the sync components, the color burst if any, and the audio--and we've taken a look at the channel assignments. We've also taken a brief trip through the typical TV receiver. Now let's go through a typical TV transmitter in the same way.

The starting point can be the TV camera itself. Like the picture tube of the receiver,

the camera has a screen and sweeps an electron beam across this screen by means of horizontal and vertical sweep signals. However, in the camera the electron beam current is originally steady as it travels from cathode to screen, and is made to vary by the brightness of the image which is focused upon the screen. This is the exact reverse of the process in the receiver, where the beam current varies and these changes of current are transformed into changes of screen brightness.

The mechanics of how image brightness makes the beam current in the camera change vary from one type of camera tube to another; some typical camera tubes are the bidicon, the image orthicon, the iconoscope, and the plumbicon. All, however, produce a video output signal which is determined by the brightness of the single spot on the screen which the beam is resting upon at any instant in the scan.

In a color TV camera, things are more complex; three camera tubes are used; and the image reaching each is filtered so that it contains only one of the three primary colors. The resulting three video output signals show how intense each of the colors is at the particular spot in question. These three signals are then combined into a single "l u m i n a n c e" signal which indicates total brightness of the spot, and also into a complicated "color signal" which indicates the red, blue, and green content at that spot. The luminance signal corresponds to the single "video" signal of a black-and-white transmitter. We'll ignore the "color signal" for a while.

The video carrier of the TV transmitter is generated in the same manner as any VHF or UHF signal; a stable crystal oscillator produces an original signal which is frequency-multiplied until the desired output frequency is obtained. Normal rf-amplifier techniques are used between the oscillator and the modulated amplifier.

The extreme bandwidth involved in the composite video signal makes plate modulation impractical for TV, and the difficulties of getting large amounts of power into a video signal of such bandwidth also tend to rule out high-level modulation of any type.

As a result, general TV practice is to grid-modulate at relatively low power levels so that the minimum of video power is required, and employ linear amplifiers to boost the transmitter power to the desired level. For ham TV, the linears are not necessary, since the modulation is usually applied to a stage producing from 100 to 400 watts output.

The vestigial-sideband response shown in *Fig. 4* is obtained by tuning the linear amplifiers to the center of the channel rather than to the video carrier frequency. Often, additional filtering is added in the antenna transmission line to reduce the out-of-channel energy remaining in the lower sideband.

Between the video output from the camera, and the modulator which adds the video information to the rf carrier, the sync information is added to produce the composite video signal. *Fig. 6* shows in some detail the nature of the transmitter sync-signal generation.

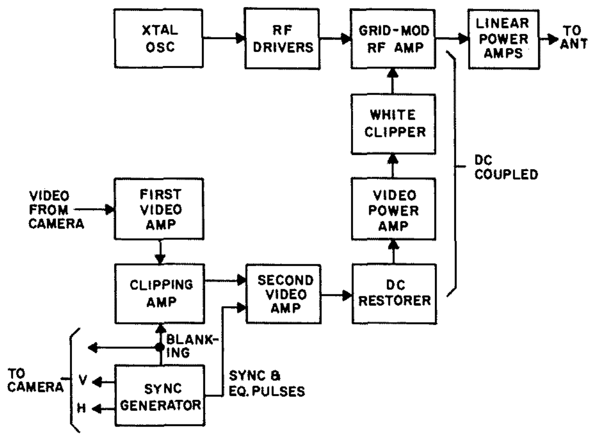


Fig. 6--This simplified block diagram of a black-and-white television transmitter shows how sync and blanking pulses are inserted into the composite video signal ahead of the modulator. Except for these stages, transmitter is functionally identical to any radio transmitter.

The original pulses are produced by a "sync generator", which is usually locked to the ac power-line frequency (both sweep frequencies are integral multiples of 60 hz. In color TV, the sync generator is locked to the color subcarrier oscillator rather than to the power line, and the sweep frequencies are very slightly different.

The sync generator provides pusles to control the sweep circuits in the camera itself, and also produces blanking pulses to the camera and clipper, and sync and equalizing pulses to the second video amplifier.

The blanking pulses kill video output during the vertical and horizontal blanking intervals and thus make space available in the signal for the sync pulses. The clipper cuts off the tops of the blanking pulses at a level just barely "blacker than black". "Black" is a video level which is 75% of the maximum composite-video signal voltage, and the blanking pulses are clipped at approximately 85% of maximum-output level. This assures that the tops of the blanking pulses are free of noise or hum.

The second video amplifier then inserts the sync and equalizing pusles into the signal to produce an almost-complete composite video signal. However, the blanking level of the signal at this stage would vary from a bright picture to a dark one as shown in *Fig. 7*; the restorer between the second video amplifier and the power video stage clamps the composite video signal to maximum output level rather than to the zero output level as shown. From this point on through the modulator itself, the signal is always dc-coupled to preserve the blanking pulses always at the same level as required by FCC regulations. The "white clipper" between the final video stage and the modulator prevents the negative peaks of the composite signal (which represent the white parts of the image) from dropping below 1/8 the maximum-output voltage.

While this completes our examination of the video transmitter, we still have more to see--because there is audio to be considered as well, not to mention the antenna itself and the special considerations of color. The audio signal from a TV station in this country is produced by a completely separate transmitter.

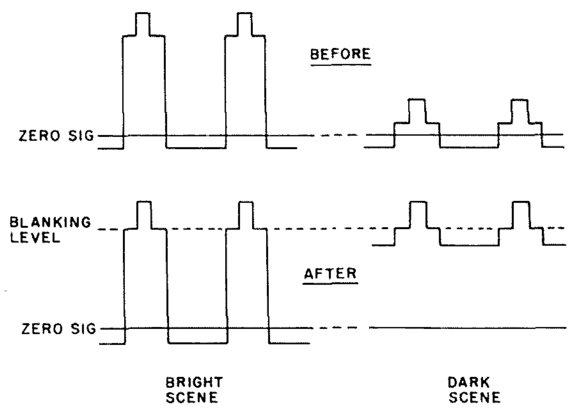


Fig. 7--DC Restorer circuit and subsequent DC coupling of signal is required to hold constant blanking level as shown here. Before DC restoration (top), entire signal shifts in level with brightness of scene. After restoration (bottom) blanking level remains constant and dark scene level is pulled up to correspond to that of bright scene. Many top quality receivers also incorporate DC restoration to preserve proper brightness ratio to final image; lesser-quality sets often omit the circuit and contrast of image varies with scene's brightness. Bright scenes have high contrast but dark scenes become grayish and contrast is dulled.

This transmitter is an ordinary FM unit; the only special points about it are that its frequency is exactly 4.5 MHz higher than that of the video carrier, and its swing is limited to a maximum of 40 kHz either way (25 kHz normal for 100-percent modulation). Also, transmitter output power cannot be great-

er than 70 percent of video transmitter power.

The audio and video carriers, though generated by totally separate transmitters, are radiated by the same antenna system, and that's where they are combined into a single channel.

TV broadcasting in this country is required by law to use horizontal polarization; turnstile arrays and variants of them are common. Normally the arrays are set up to compress the beamwidth in the vertical plane, and give omnidirectional coverage in the horizontal plane. A turnstile antenna does this by using two sets of radiating elements, one for east-west coverage and the other to cover in the south.

north-south direction. The two are fed 90 degrees out of phase.

The audio and video transmitter outputs are connected to the antenna array by a diplexer arrangement such as that shown in *Fig. 8.* This arrangement does *not* include the

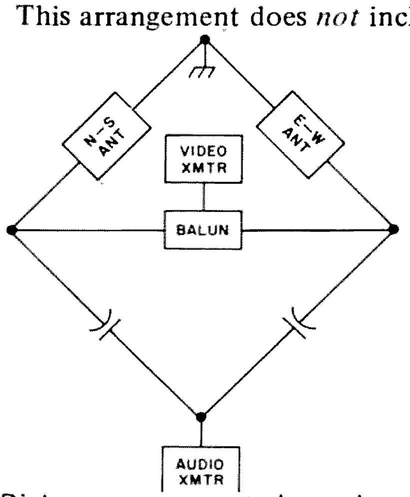


Fig. 8--Diplexer arrangement shown here is used to couple both audio and video transmitters to turnstile antenna array while isolating each transmitter from the other. Similarity to Wheatstone bridge circuit is emphasized in this drawing; isolation is produced by the balanced-bridge principle.

phase shift necessary for operation of the turnstile antennas; its purpose is to permit all the output of each transmitter to flow to the antennas, without any of the output of one transmitter being routed to the output circuit of the other transmitter. The similarity to a Wheatstone bridge circuit is apparent, and it functions in exactly the same manner to isolate the transmitters from each other.

All the way through, this installment, we've been putting off any detailed look at the way color TV works. We can't do so any longer. Now that we have a fairly complete idea how black-and-white TV operates, it's time to throw caution to the winds and look at color.

Before we get into the special requirements, though, we must pause a few moments and look at the whole idea of "color" itself.

"Color" is a characteristic of light, and light is simply electro magnetic energy of fantastically high frequency but otherwise identical to radio waves. The color of light *is* its wavelength (or frequency, of course) and what we know as "white" light is actually a mixture of all the possible colors of light which our eyes can perceive.

Most objects have no light of their own; we see them because they reflect light from other sources. The color of light which is reflected is not necessarily the same as the color of all the light which falls on the object–but (in most cases) the light reflected *is* of the same color as at least a part of the light which falls on the object.

For instance, lips reflect red light during the daytime; the sun's light contains plenty of red to be reflected. But at night under high-intensity "whiteway" lights, which are rich in blue but have almost no red at all, lips appear black. There's no red to reflect, and the blue isn't reflected.

What actually happens to produce color in any object which has no light of its own is that all the light of any *other* color is absorbed from any light which happens to arrive; all that *can* be reflected is whatever happens to be left.

Thus a leaf is green because it absorbs the light of any color *except* green, which leaves only the green light for us to see it by.

If the light falling on anything happens to have only one color in it, then anything which absorbs that color will appear to be black or at least dark gray, and anything which does not absorb that color will be light.

Most of us were taught in primary school art classes that any color we want can be obtained by mixing the three "primary" colors red, blue, and yellow. What most of us were *not* taught at that same time was that the same effect could be obtained by mixing the three "primary" colors of light rather than paint–and that the primaries for light were slightly different than those of paints!

When mixing paints, the primaries are magenta (almost red), cyan (between blue and green), and yellow. Magenta removes the green from any light which falls upon it; cyan removes the red; yellow removes the blue. When we mix light, the primaries are green, red, and blue.

We can prove this with three spotlights and a set of red, blue, and green filters. With one filter on each spotlight we can aim them to produce overlapping circles. Where all three of the light primaries are present, we get white. Where red and green are mixed but blue is absent, we get yellow. Where red and blue mix but green is absent, we get magenta. And where blue and green mix in the absence of red, we have cyan. The effect is similar to that shown in *Fig. 9*. The color sequence around the ring of white light in the middle runs from blue through cyan through green through yellow through red to magenta.

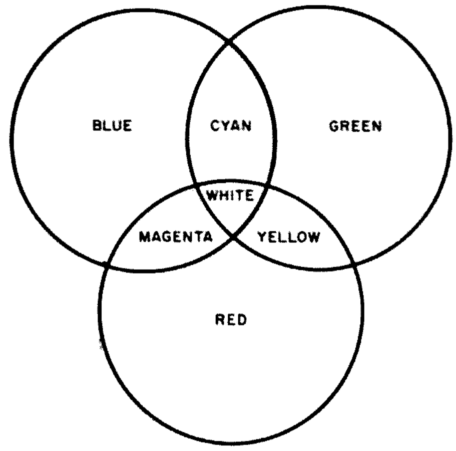


Fig. 9–Generation of color by mixing colored light from three primary sources of blue, green, and red is indicated here. This differs from the traditional production of color because in this case colored light is used rather than colored paints or inks. The color in color TV is generated by mixture of these same three primary colors.

Exactly the same sequence of colors is produced if we mix cyan, yellow, and magenta paints; where the yellow and magenta are mixed, the yellow removes any blue from incoming light while the magenta removes any green. The only light primary left to be reflected is red. Similarly, where cyan and yellow are mixed the cyan removes any red and yellow removes any blue; what's left is green.

Now back to color TV. The picture we see on the screen of a color TV set is produced by a sweeping spot–which is actually a *source* of light. This means that the primary colors we'll be using in color TV are the light primaries, red-blue-green, rather than the paint primaries you're more likely to be familiar with. In case of confusion, it may help to remember that one is the other turned inside out–and it may not!

We have already noted that in the color TV camera, three video signals are produced, one for each of the primary colors. Each of these

signals tells how much of its color is present in a particular part of the image at a given instant.

The three original signals, E_b E_r and E_g, are combined into three new signals. Each of the new signals is a combination of all three of the originals, but the rules by which they are combined differ for each of the new ones.

One of the new signals is combined by a rule which takes into account the relative brightness of each of the original colors. "White" light is 59 percent green, 30 percent red, and 11 percent blue, and so the original green signal contributes 59 percent of this new signal while the original red puts in 30 percent and the blue makes up the remaining 11 percent.

This new signal, sometimes called E_Y but as the luminance signal, carries *all* of the brightness information for the picture. It corresponds exactly to the single video signal of black-and-white and goes through all the same steps.

The two remaining new signals are combined by other rules. If you're really interested in the precise rules for them, and are ready to read several pages of trigonometric equations to learn them, you can find them starting at page 1000 of the fourth edition of *Electronic and Radio Engineering* by F. E. Terman. The important thing, for our purpose, is that the rules produce a pair of signals which tells us how far, and in what direction, the color at that spot in the picture is from a neutral gray tone. These signals are known as the chrominance signals; one is the I signal and the other the Q, for "in phase" and "quadrature".

Both of these signals originally occupy the same bandwidth as does the luminance signal--from 60 hz to above 4.3 MHz--but they are filtered to narrower limits because the eye doesn't sense small changes of color. The I signal is limited to a 1600 kHz band width, and the Q signal is cut down to 600 kHz, without visible loss of detail.

The Q signal is then DSB-modulated on the color subcarrier. The I signal is also DSB-modulated on the same subcarrier after a 90-degree shift in subcarrier phase. The subcarrier is suppressed from both signals, and the I-signal output is filtered to remove that portion of its lower sideband below 600 kHz. Finally, both the I and Q output signals are put together; the resulting single chrominance signal has no carrier, double sidebands for modulating frequencies below 600 kHz, and a single sideband for modulating frequencies

Make Your Own Professional Name Plates

The last word in putting the final 'polish' on a piece of home-brew gear is to provide it with a professional appearing name plate. Applying decals directly to the panel is more often used, but this method makes such lettering appear more like one of the many individual component labels.

To make a name plate which will stand out and serve to identify the unit as a whole, is a simple matter. Apply the small decal letters, preferably of the dry transfer type such as the Ami-Cals, to a small piece of scrap bakelite or a piece of polished metal, if you prefer. Drill two mounting holes and attach the finished plate to the equipment panel with small sheet metal or machine screws.

The accompanying photograph illustrates how the author labelled a recent project using a piece of scrap bakelite 1/16 inch thick, cutting to size and bevelling the edges with a file. Try it on your next project; You'll be surprised what a 'professional' touch it will add to a piece of home-brew gear!

Howard S. Pyle; W7OE
Mercer Island, Wash., 98040

above 600 kHz and below 1600 kHz.

This combined chrominance signal is applied to the transmitter's second video amplifier, just as are the sync and blanking pulses. At the same time, the color burst (taken directly from the subcarrier oscillator) is put onto the back porch of each horizontal blanking pulse. The complete color composit video signal is then transmitted just as is a black-and-white signal.

While both I and Q signals are present throughout the video channel, they have little effect upon the picture itself because the color subcarrier is an *odd* multiple of half the line frequency. This means that any effect of an I or Q sideband upon the electron beam during one sweep of a picture line will be cancelled out by an opposite effect on the next sweep of that same line. The only effect which is not cancelled is a 15 Hz flicker in areas of small, fine detail. You may see this from time to time on your TV screen; it affects both color and B&W sets whenever color is being transmitted and fine detail such as checked fabric appears in the picture.

At the receiver, the I and Q combined chrominance signal is picked off by appropriate filters and applied to a pair of synchronous detectors which are very similar to those used for reception of ham DSB signals. The major difference is that in ham DSB, we must get the carrier back from information contained in the sidebands themselves, and in color TV, the color subcarrier frequency is sent to us in the color bursts which occur at the end of every line.

The outputs of the two synchronous detectors are again filtered to remove the Q signals from the I channel and vice versa. Then the I, Q, and Y signals are applied to three circuits which combine them in an exact reversal of the rules by which they were originally produced at the transmitter. These circuits produce as their outputs replicas of the original red, green, and blue video signals.

Each of these three primary-color signals is amplified separately and applied to the corresponding electron gun of the color picture tube. The result is glowing color on the screen.

For this process to work right, the I and Q signals must bear the same relationship to each other and to the Y signal at the receiver that they did at the transmitter. However, transmission-path differences can disturb this relationship, and additionally the differences from camera to camera at the transmitter can introduce additional disturbance. All these disturbances can be corrected by fine adjustment of the phase relationships in the synchronous detectros; this is the function of the "hue" control on color TV receivers.

How Does Television Interference Occur? Television interference falls into three main classes, each of which occurs for different reasons. The three major classes are (1) TV receiver overloading by the interfering signal, (2) interference, either audio or video, by spurious emissions, and (3) interference by harmonics of the interfering signal. A fourth class consists of interference created by uncontrollable cross-modulation.

Overloading of the receiver normally occurs only if the TV receiver is located within a few hundred feet of the transmitter causing the interference. It is caused by the transmitted signal getting into the TV circuits--either on the antenna line, via the power line, or by direct pickup through the TV cabinet--and overloading some critical circuit. It may easily be recognized by the fact that it is present on all channels in equal degree, and almost invariably disappears if the transmitter is operated into a dummy load rather than into its antenna.

Interference by spurious emissions includes such things as overmodulation splatter, key clicks, and parasitics. At the TV set, this type of interference may resemble that caused by harmonics, but is likely to be much more intermittent.

Harmonic interference is the most common form of TVI and may usually be identified by the fact that it affects different TV channels differently. However, if the harmonic happens to fall at the IF frequency of the TV set, it may affect all channels equally. This rarely occurs since most modern TV's incorporate filtering to prevent signals at the *if* from getting past the first few stages.

Uncontrollable cross-modulation is an interfering signal produced by some non-linear element not under the control of either the amateur or the TV set owner--such as oxidized guy wires on a power pole, or a rusted gutter on the neighbor's roof. When two strong signals reach such a non-linear element, they may mix just as they would in the mixer stage of a receiver to produce sum and difference frequencies. If one of these difference frequencies falls in a TV channel, it will be an interfering signal for that channel.

Interference of this type is called a "phantom" signal; its identifying characteristic is its extreme randomness, since both the strong

signals must be present for it to be produced. If either transmitter goes off the air, the phantom disappears. When the phantom is present, however, the modulation of both the original signals may be present on it and capable of being understood--so the TV set owner may be completely convinced that the ham is at fault.

Fortunately, this type of interference is rare enough that you may never experience it--because when you do, only a painstaking search for several miles around can locate the offending non-linear element. Frequently it's easier to merely avoid use of the particular frequency which results in a troublesome phantom!

Most TVI is due to harmonic radiation; good design of the amateur transmitter, coupled with good operating practice, can hold the problem to a minimum--but any transmitter *must* radiate at least some harmonic energy, because of the way in which an amplifier works. The object of harmonic chasing when battling TVI is to reduce these harmonics to such a low level that they will not be troublesome.

We've already looked at the frequencies allotted to television in this country, and the use made of the space within each channel. *Fig. 10* relates the TV channel assignments to the various harmonics of the popular ham bands.

The exact effect of harmonic interference depends upon both the exact frequency of the harmonic, and the type of modulation employed. If the harmonic is within a TV channel, it will form a beat frequency with both the video and the audio carriers. If either beat frequency is below 15,750 hz, horizontal bars will be produced on the screen. If the beat is above the horizontal sweep frequency, vertical bars will result. As the beat frequency moves around 15,750 Hz, the bars rotate from horizontal to vertical, and produce a cross-hatch pattern on the screen.

An unmodulated carrier (or harmonic) normally produces only a steady cross-hatch pattern. A frequency-modulated signal produces a cross-hatch which appears to rotate with the modulation. CW turns the cross-hatch on and off. AM, however, produces modulation bars which we have already met.

An amateur FM signal may, if its harmonic

Fundamental	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
3.5 to 4.0 MHz				NONE					
7.0 7.3					TV IF		TV 2	TV 3	TV 4
14.0 14.4		TV IF	TV 2	TV 4	TV 6	FM BC			
21.0 21.45		TV 3	TV 6	FM BC		TV 9	TV 13		
28.0 29.7	TV 2	TV 6			TV 6	TV 10-11-12			
50 54	FM BC		TV 11-12-13					UHF TV	UHF TV

Figure 10--Possibilities of harmonic interference from amateur transmitters are listed in this chart. Harmonics higher than 6th are not likely to escape from properly designed and operated transmitters. With reasonable care all harmonics can be controlled.

is very close to that of the TV audio carrier, come through understandably. However, in most cases when a TV viewer reports he is hearing rather than seeing amateur interference, a particular type of overload–rather than harmonic interference–is present.

This type of overload is not confined to TV sets; it may hit hi-fi equipment, hearing aids, AM radios, or almost any device incorporating an audio amplifier. Transistorized amplifiers appear to be particularly sensitive to such interference.

What happens is this: The rf carrier–which must be carrying AM for the signal to be heard–reaches the input stage of the audio amplifier by any of a number of possible routes. There, the amplifier's input stage acts as a grid-leak detector to demodulate the signal into audio; from that point on the amplifier is not able to tell the unwanted audio from the signal it is supposed to be processing, and you have interference.

The sure cure for this problem is to prevent the rf from reaching the amplifier input stage. The normal means of doing this is to add an rf bypass capacitor directly from grid to cathode of the audio stage involved. If an 82 pF capacitor is used virtually all rf will be removed and no audio will be affected.

How Is TVI Suppressed? Regardless of the cause, all TVI is suppressed by the same basic means; the interfering signal is disposed of. Exactly how this is accomplished depends upon the particular type of interference involved.

Interference due to overload requires action at the TV receiver. This action may be such a simple matter as installation of a high-pass filter on the TV-set antenna terminals, and may be such an extreme matter as completely shielding the TV chassis from your signal. As a rule, the less done at the receiver the better. If you can demonstrate that you cause no interference to your own set, you are in a position to wash your hands of the receiver-overload problem. The amateur is not responsible for design deficiencies in TV sets, and the FCC has recognized many times that many of the interference problems are directly due to TV-set design flaws.

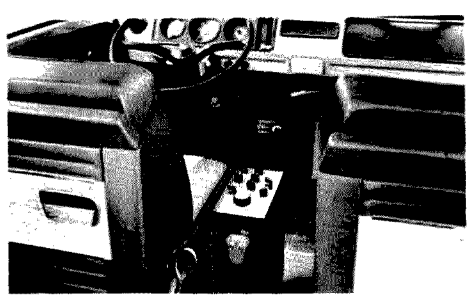
Interference due to spurious emissions is suppressed by suppressing the spurious emissions. All spurious emissions are illegal in their own right, and must be absent from your signal in order to be within the rules.

To suppress harmonics, the first steps are to be sure that as few as possible are being generated in the first place. Class C amplifiers should be operated with the minimum grid bias which will produce satisfactory operation. Tuned circuits should be coupled in a manner which will discriminate against harmonics and transfer only the desired frequency from one stage to the next. All power leads should be filtered and bypassed. Any stray resonances in the transmitter which happen to fall inside TV-channel limits should be detuned by adding capacitance, or have their Q killed by inserting resistance if practical. This will help hold the unavoidable harmonics inside the transmitter cabinet.

Tuning of all stages should be accurate, and a tuned antenna coupler should be used. "All-band" antennas are popular, but they offer no rejection of harmonics and should be avoided if TVI is a problem. A low-pass filter between the transmitter and the antenna will help reject high-order harmonics.

VHF operators face a somewhat different problem, as *Fig. 10* shows. The fundamental signal on 50 MHz can be more troublesome to Channel 2 than any harmonic of a HF signal. While sharply–tuned antenna couplers, and tuned–line wavetraps at the TV receivers, can help with this problem, the most reliable cure is simply careful operating practice. Choice of an operating frequency to minimize TVI, and of operating hours to avoid most viewers, does more to eliminate the problems than any amount of technical tinkering can accomplish in this case.

Next Month. VHF characteristics and principles of propagation will be our subjects in the next installment.



Factory Transceiver Installation

The ham crew at the Volkswagenwerk has been working on a ham mobile unit which may be released as optional equipment and be available through all Volkswagen dealers. Detroit, please take notice that the Germans are getting ahead of you again. That is the Drake TR-4 beside the seat. The power supply mounts behind the front seat cushion, out of the way. The whip (a Hustler) is on the back of the bus.

A NEW System For Learning Morse Code!

Robert C. Erwood, K9AAU
2823 W. Lyndale Ave.
Chicago, Illinois 60047

The difficulty of becoming a proficient Morse Code operator is apparent in that at least 25 hours of intensive study is necessary for the average person to learn to copy a modest five wpm. After disappointing experiences in teaching with the present methods, I have set about to scientifically devise a "best way."

When you take a message delivered in code, have you ever caught yourself making up your mind as to what the letter being sent is before the character has been completely received? This is significant in my new system of teaching code to beginners. It is based on the simple code structure.

All communications are made up of bauds. A baud is a length of time of tone or of silence. A baud is the length of time it takes to send a dot. Three bauds is the length of time the tone is sounded to send a dash. One baud is the time the tone is silenced between dots and dashes in building the code characters. Three bauds is the time of silence allowed between characters to distinguish them from one another.

If a beginner knows only two characters, say E (one sounded baud) and T (three sounded bauds) then, when he hears either of these two characters, he makes up his mind which it is after only two bauds. The third baud can be called 'slack time'. He is going to have to 'unlearn' this slack time habit and when a habit must be 'unlearned' progress is slowed. The beginner establishes the habit of determining the character after the second baud but when he learns the new character I (sounded baud, silent baud, sounded baud) he must suppress his habit and wait for the third baud before he can determine what the character is going to be.

An extreme example would be, if the beginner only knew E (one sounded baud) and Zero. He would know which character the teacher was sending after only two bauds because even though zero is composed of nineteen bauds, some sounded and some silent, he knows it is not E when the first tone sounded continues to the second baud.

The science of psychology tells us that learning is a continual process of establishing habits and having to suppress them and add new habits. This applies to learning the code. The characters should be taught in a sequence that will keep the necessity of changing habits to a minimum and not according to the frequency of use or according to surmised patterns of difficulty which are the current methods of presentation.

It is a known fact that tones can be compared which are only 15 milliseconds in duration. There is a strong tendency to decide what a character is as soon as possible and not wait for the end of the last tone. These two premises constitute the foundation of my new system for learning the Morse Code. The idea is to minimize the necessity of changing decisions which takes time.

There must be a scientific order of learning in order to avoid unlearning bad habits which will slow up any study. If a student learns the letters as they are usually taught without scientific order of sequence, bad habits will be formed which then must be unlearned. Receiving code is not the same problem as sending and for speed practice the teacher will send the code symbols the student has learned. Say E and Zero are the known characters and those are the ones the teacher is sending. The student will not wait until all the dashes have been sent before deciding it is a zero and not an E. The student will actually be making up his mind that the character is a zero after one baud when the first tone of the character continues three bauds and becomes a dah. Actually the student has heard T which he has not yet learned and he is deciding the character is a zero when there are yet seventeen bauds to go in that character. Thus the student is establishing a pattern he will have to break in order to learn T and M and O for example. To avoid this difficulty the student must learn the 9 along with the zero so

he will withhold his decision as to the identification of the character until the last tone has been sounded.

In my new system the first characters taught are the 9 and the Ø. Nine, dah-dah-dah-dah-dit and zero, dah-dah-dah-dah-dah have the similarity that the decision as to the identification of the character must be held off until the last tone is sounded. The beginner does not yet know that dah all by itself is T, or that dah-dah is M, or that dah-dah-dah is O, and is consequently not changing his mind regarding the identification of the character but is withholding his decision until the last tone.

The following is the progression of the characters as they should be taught. I have divided them into six lessons. Each lesson must be mastered before progressing to the next.

Lesson 1: 908OEI
Lesson 2: Z7QGM
Lesson 3: KCYDZ6B
Lesson 4: NTJPW
Lesson 5: IRA2FU
Lesson 6: 5H43VS

...K9AAU

Letters

Tesla

Dear Kayla,

Thanks for the success story on Nikola Tesla—the best I've yet read on him. A good shot in the arm for the younger set!! I suggest more such stories for the incentive that it may help to create.

Sam J. Main, WØHQW
Brainerd, Minnesota

Dear Kayla,

FB on the life story of Tesla—let's have more of the same. I've been reading it mornings on the Net to the non-73 subscribers, hi. Let's have more of these articles about the *greats* who pioneered the electronic and electrical field.

Howard, KØHPF
Denver, Colorado

Dear Kayla,

Say...you really rang the bell here with that splendid article on Tesla in the February issue. I can't begin to tell you how much I enjoyed it. It was like having a philosopher at a science club. All technique and no history makes a magazine a dull read. Very bright and interesting.

James R. Belt, Jr., WØJIH
Omaha, Nebraska

Ed. note: Space does not allow for all the letters about this one article. There have been at least fifty with the same sentiments expressed above. Below is the one dissenter.

Dear Editor,

Why do you take up so much space with junk like the article on Tesla? This and other nontechnical articles make me inclined to cancel my subscribtion.

(Unsigned)

License course

Dear 73,

In reference to your article Getting Your Higher Class License (Part X—Basic rules and units) you have more than adequately described, among other things, impedance in the most common forms of resistance, and capacitive and inductive reactances in an admirable effort to avoid some of the trigonometry and calculus which often tends to snow a good majority of amateurs, not in the engineering field. Your staff should be commended on a fine job, one well worth the effort.

Stuart M. Kravitz, WA3BSC
Middletown, Pennsylvania

Dear Editor,

While I have read the publication for quite a few years, the quality of material lately has impressed me to the extent that I want to be assured of receiving every issue.

You are to be particularly commended on the series of articles on the Advanced Class License. These are truly outstanding. Even though I hold an Advanced License, I have learned a great deal from the material and wish I had had material of this quality to study when I took my exam. My compliments on an increasingly fine publication.

Dr. Lawrence A. Edler
Santa Cruz, California

Dear Wayne,

I want to extend my thanks to both you and your staff for an outstanding job on preparing and presenting articles on "Getting Your Higher Class License." I have read, re-read and outlined every inch of those articles. I'm happy to know there are people who will share their knowledge and understanding of the "State of the Art" in such superlative fashion. Mucho thanks.

Walter Seighman WA3AXQ
Belle Vernon, Pennsylvania

Dear 73,

I would like to add my "thanks" to 73 for offering the advanced Class Study Course. This course, which has been well put together, should make the necessary job of studying easier for those who will take the time to go through it.

Richard Gassman, WB6YIL

Dear Kayla,

This is to agree and disagree with your December editorial. The magic of radio still exists when properly sold by people like yourself. To qualify this, I just passed my Advanced exam, SOLELY due to your last nine articles. Face it, man, you can't find hams with time and ability to simplify and explain a complicated art. The old hack is memorize the answers, pass the exam, and learn later. Hell's Bells, that's why we have so many lids...they will never learn. Each article was well written and aimed at the man, like myself, with no knowledge of electronics.

Dr. Dan A. Farrell
Globe, Arizona

Bouquets and Brickbats

Dear 73,

My sincere congratulations to you and the entire staff of your publication!

The best amateur radio magazine that is for sure, complete and interesting. Please put me in the large list of good friends and fans of your non-plus-ultra publication. Keep up the excellent work for the benefit of the radio amateur family.

Joseph M. Francisco, ex LU6DEM
Whittier, California

Dear 73,

Congratulations on the quality of 73 Magazine. Your magazine is really top at all points of view and very interesting to read.

Gerard Bunge
Tucson, Arizona

Dear Wayne,

The front cover of the January issue sure has impact. It has me broken out in a sweat. I can't sleep. I can't eat. I've stopped looking at the "architecture" of the opposite sex. If I don't make it the first time up, I'm going to take my "Chicago typewriter" out of the violin case and mow the whole damn FCC crew down. Hi . . .

Frank A. Phillips, W5QPH
Houston, Texas

Gentlemen:

Last week when I stopped off at Uncle George's radio store in Wheaton, Md., for some radio parts, one of the clerks told me that 73 Magazine recently ran a series of articles on the questions and answers, and other information, on the new Advanced and Extra Amateur Radio Licenses.

"The best information on this subject that we have ever seen," is the way one of the clerks put it.

DX QUIZ . . . Answers

The quiz is on page xx.

Israel	040	Bermuda	111
Togo	081	Singapore	336
Burma	352	Iran	030
French Somoliland	047	Nepal	001
Ireland	048	Galapagos	178
Liechtenstein	046	Guam	303
Egypt	047	Canal Zone	165
Heard Island	137	Ascension Island	103
Hawaii	269	Virgin Islands	127
Venezuela	138	Ceylon	007

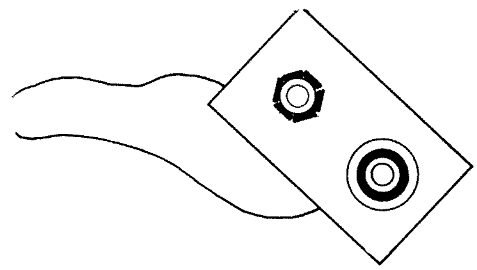
Score five points for each beam heading that you guessed within five degrees (Minnesotans should guess within three degrees). Don't feel discouraged if you didn't do too well. In a test similar to this a group of DXCC'ers averaged about one right. The top man had only three correct.

Solution To Cryptogram

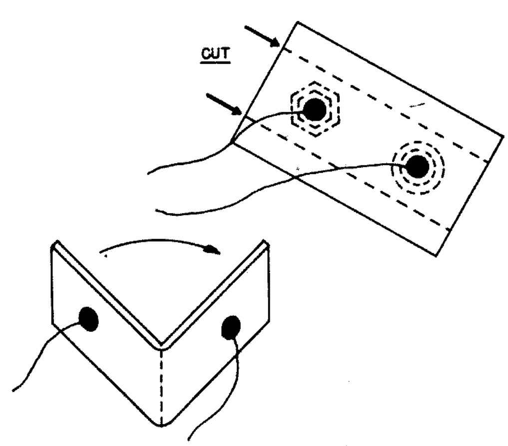
A changing electric field sets up a magnetic field, and a changing magnetic field generates an electric field.

Top Tip

If you use small transistor equipment, you probably have a pile of old dead 9V batteries in the junkbox. If they look too useful to throw away, maybe they are. Just grab one and twist off the metal casing, pull out the plastic top, and you have a 9V connector guaranteed to fit the same size battery from which it was removed. Solder on whatever you need in the way of leads and you're in business. See **Fig. 1.**



Old dead "B" batteries always seem to outnumber good ones, but there is a use for them too. Again, take off the top, which is usually cardboard or a thin fiber material. Now trim the top, as shown in **Fig. 2a**, fold in half, add leads, and (**Fig. 2b**), you have a free SPST switch suitable for haywired circuits or anywhere that you don't want to waste one of your good "store-bought" ones. The 9V tops are usually too stiff for this job, but if you want to go to the trouble of remounting the connectors on different material, they will work just as well. Now all you have to do is figure out something to do with the black junk that's all over your work bench.



David B. Cameron WA4VQR

I wonder if 73 Magazine has reprints of these articles available for purchase, or has considered publishing the series in pamphlet form. If you have reprints, I'd like to get a copy or two.

Jack R. Adams, W4TMJ
Falls Church, Virginia

Dear Sirs,

I would like to take this opportunity to say that the material in your magazine has deteriorated considerably in the past year. Improve, or my subscription will not be renewed.

B.S.Hargrave, K7NWN
Bellevue, Washington

Can't win 'em all, they tell me.

Odds 'n' ends

Dear Kayla,

Four years ago, when my husband, K5DGI, planted his ninety-foot tower in the middle of our rather small back yard, after promising that it would be well over to one side, we came up with the idea of planting climbing roses up the sides to camouflage the steel and wires. The roses have turned out to be quite attractive during the few weeks they are in blossom. However, the most useful side-effect has resulted from the thorns, which provided a highly successful year-round deterrent to the temptations of tower climbing by our own little boy and all the other neighborhood gremlins.

Mrs. Wesley Attaway, K5DGI
Shreveport, Louisiana

Dear Kayla,

A little gadget that is a handy operating aid for DX'ers can be made out of an ordinary desk calendar, though any small calendar would do, of course. The good propagation days on the calendar can be marked with a circle. Fair days left alone and poor days boxed.

My op aid is on a 3x5-inch file card with a little V-shaped cardboard support Scotch-taped to the back. It sits on my receiver next to my GMT clock.

The column width of the magazine will accommodate the art enclosed. It might look good at the top of the propagation column above the three data blocks. The only trouble with this idea, though, is that guys may be tempted to cut it out of the page, thus ruining the magazine. Maybe it should just be shown as an idea.

Alf Wilson, W6NIF
San Diego, California

Dear Wayne,

I am sure that your mail this month will include many interesting, and witless suggestions, with respect to your idea for dividing 20 meters into slots for homogeneous groups.

My contribution, however witless, is to suggest that we eliminate your designation of 14298, cultural discussion, as being totally devoid of interest to hams and that we set this frequency aside for the feeble minded; particularly those whose need to communicate is satisfied by the transmission of unidentified jamming signals.

Mike-fright may also account, in this day of thoroughly operational vox control, for the fact that QSO's still consist largely of interminable, alternating, hand-switched transmissions; distinguished both for vacuity and tedium. Vox operation soon discloses the conversational cripple, rendering small talk even smaller.

Frank Melville, W2AQK

Caveat Emptor?

★ **Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

★ **Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.**

★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

★ **We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.**

★ **For $1 extra we can maintain a reply box for you.**

★ **We cannot check into each advertiser, so Caveat Emptor . . .**

RAGS (Radio Amateurs of Greater Syracuse) annual hamfest on Saturday March 29, 1969, at Song Mountain. Lee Delasin, WA2DAD, P.O.Box 88, Liverpool, New York 13088.

HALLICRAFTERS SX-100, $130; SX-111, $120; ARC-5 Two-meter 30 wt. xmtr w/pwr supply & 50 wt. modulator, Cush-Craft 7 el beam, $50; Homebrew Converters (not junk) for 50, 144, 220 MHz, $20 each; 6 meter Squalo, $7; Globe HG-303 90 wt CW, $20. WA2PCL, Richmond Hill, N.Y. (212) VI.9-8458.

WANTED OLD CALLBOOKS: 1920 to 1950 State price and condition. Will trade meters, ham parts for same. KEMP, Box 307, South Lake Tahoe, Calif. 95705.

TEST EQUIPMENT WANTED: Any equipment made by Hewlett-Packard, Tektronix, General Radio, Stoddart, Measurements, Boonton. Also military types with URM-( ), USM- ( ), TS- ( ), SG- ( ) and similar nomenclatures. Waveguide and coaxial components also needed. Please send accurate description of what you have to sell and its condition to Tucker Electronics Company, Box 1050, Garland, Texas 75040.

WANTED: Military, commercial, surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

NORTHERN CALIFORNIA HAMS. Best deals—new and reconditioned equipment. Write, call or stop for free estimate. The Wireless Shop, 1305 Tennessee, Vallejo, Calif. 707-643-2797.

DO YOU KNOW SOMEONE WHO IS BLIND who would like to receive tape recorded excerpts from 73 without charge? For details write: IEEE, c/o Lester W. Cory, SMTI, North Dartmouth, Mass. 02747.

HQ-145 WITH CALIBRATOR, good condition $130; also Dx-60 with HG-10 VFO $40. WB6LNQ Bob Nottelmann, Rt. 3, Box 60, Chico, Calif. 95926

20TH GRAND RAPIDS Amateur Radio Assoc. (ARRL sanctioned) State Convention May 9-10, 1969. Write GRARA Box 1333, Grand Rapids, Michigan 49501, for tickets and information.

SALE: Hammarlund HQ170, Heathkit DX-100, National HRO-7R, SX-28, cubical quad, Signal Corps Frequency Meter BC221N, assorted instruments. Write WA2TET, 410 Twist Run Road, Endwell, N.Y.

GLASS HOUSE HAMS-Compiling a directory of hams employed in the glass container industry and allied fields. Send information to WB2AHF, 1197 West Woodcrest Drive, Vineland, N.J., 08360

MOULTRIE AMATEUR RADIO KLUB annual Hamfest April 27, 1969, at Legion Pavillion, Sullivan, Illinois. Everyone welcome. Door Prizes. Refreshments on the grounds.

SELL—PMR-7, $42; Heath – Xmitter-MT-1—$39; Mobile supply MP-1—$15; Heath 3" scope OL-1 $23. Good to excellent condition. Include postage. Robert Franck, 12280 Wilfred, Detroit, Michigan 48213.

HW-32 WITH AM-CW, newer knobs, extra meter, etc., $100; microphone, 14 AVQ antenna, all like new; WA7DXQ, Box 7668, Phoenix, Arizona 85011.

COLLINS PTO wanted models 70E15, 70H12, 70E24. State condition, unsealed carton, new or used; need all filters for 75A4 receiver WA4YFI, Bill Smitherman, East Bend, N.C. 27018.

FOR SALE: Precision ES500A, 5" scope, $85; Sig. Gen. E200, $45; Tube testers: EMC 208 w/case $25; Mercury 201 w/adapter, $4500; Eico 950A, RCL, $25; all FOB. R. Wendel, WB2YYX, 160-20 Grand Central Pkwy., Jamaica, N.Y. 11432.

FOR SALE: Piolet AM-FM tuner Model AF-723; Equipment crafters (Craftsman) amplifier Model 500; Collaro Coronation Model RC440 changer; Oak enclosure w/4 speakers; $225 FOB. R. Wendel, WB2YYX, 160-20 Grand Central Pkwy., Jamaica, N.Y. 11432.

TELETYPE MOD. 14 Reperforator w/automatic tape take up rewinder new, unused, $69.95—4-400's $14.95—transformers: Plate 5KV-1.6ADC $59.95—Modulator 811A's $35 – Filament 12.6VCT-10a $4.95. Ideal for transistor supply, battery charger, catalog 10¢, Fertik's, 5249A "D", Phila., Pa. 19120.

SALE: Heath Apache TX-1; Motorola TU535-Mike, both mint condition $115—FOB, Pr 4x150A $30—Robert Ross, 1436 Lenape Road, West Chester, Pa. 19380.

ATTENTION 160 METER FANS: Change any coax fed 75/80 meter inverted vee/dipole into an efficient 160 meter antenna. Adapts within seconds, right in the hamshack. PL-259 and SO-239 connectors. Perfect for residential areas. TOP BAND SYSTEMS' MODEL 86ADP 160 meter adaptor. $4.75 Ppd. Martin Hartstein, 5349 Abbeyfield, Long Beach, Calif. 90815.

HAMFEST, May 25th at Wabash, Indiana, 4-H fairgrounds, $1 registration, no selling charge, rain or shine. Information? Write K9AYB, 434 Stitt Street, Wabash, Indiana 46992.

WRL'S USED GEAR has trial-terms-guarantee! KWM1, $299.95; TR3, $399.95; SB34, $319.95; Galaxy V, $229.95; Galaxy 300, $139.95; HX20, $149.95; Invader 200, $269.95; T4X, $319.95; SX146, $189.95; HR20, $79.95; SB300, $229.95; Galaxy 2000 & PS linear, $329.95. Hundreds more-free "blue-book" list. WRL, Box 919, Council Bluffs, Iowa 51501.

SELL: HEATHKIT HR-10 receiver, minus crystal calibrator. Excellent condition. $50 FOB. Or will trade for Heathkit IO-21 oscilloscope. WA9UEK, Art Pahr, Box 1, Plymouth, Wisconsin 53073.

3 PLASTIC HOLDERS will frame and protect 60 cards, $1 - or 10 holders $3. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, Tennessee 37066.

RECEIVER BAND CHANGING switch 25¢ postpaid. Send for our surplus electronics parts and equipment flyers. Bob-Frank Electronics, P.O.Box 1327, Harrisburg, Pa. 17105.

INDIANAPOLIS HAM CONVENTION: (Sat.) May 24. (9 to 5) at beautiful Lafayette Square Mall. Indoor manufacturers displays-for sale or auction. Free out-door flea market. 80+ shops, cinema, for XYL and kids, inside airconditioned mall. Airports & Interstate—½ mile. Write: Indianapolis Ham Association, 309 Benton Drive, Indianapolis, Indiana, 46227.

KWM-2 AND PM-2 POWER SUPPLY. Recent complete factory checkout. Like new condition, $695. Dan Hingtgen, WØWIG, 272 Crandall Drive N.E., Cedar Rapids, Iowa 52402.

GONSET-IV-2 meter, very good condition, $200. Companion VFO, $60. (Both $250). WA2OHN 845 Cliffside Avenue, N. Woodmere, N.Y. 11581.

HAMMARLUND HQ110A, Mint Condition, little use, with speaker, $165. DX60 with HG10 VFO, good condition, factory checked, $75. WB2ZIA Box S-1305, Hoboken, N.J. 07030.

FOR SALE TELETYPE Equipment Model 19, 15, and M-14 Reperforator Complete. Carl Calfee, Lanexa, Va. 23089; near Williamsburg, Va. Phone 564-3500.

SELL: NC-300; Johnson Ranger; Astatic Mike, DD104; Low-pass filter; SWR bridge; Bug. First offer over $200 takes. K6SUQ, 5 Rydal Court, Orinda, California.

HAMFEST sponsored by Lancaster & Fairfield County ARC at Derby Downs one mile south of Lancaster, Ohio, on Bis Road, Route 793, June 8th. Gigantic Swap Shop. $1 registration with prizes every half hour. Main prize drawing. Good food at reasonable prices.

DUAL-UNIT MODEL 28 R-T tape set, typing reperforators, TD's, gear shifts for 60, 67, 75, 100, 107 wpm, excellent cabinet—$500. Other FAX, FM gear, list free. White, 5716 N. King's Hwy, Alexandria, Virginia 22303.

TECHNICAL WRITERS AND EDITORS wanted. Free-lance, part-time. Various electronics topics. Standard rates paid. Send resume. Electronic Publications Company, P.O. Box 504, New Hyde Park, N.Y. 11040.

NEED A VARIABLE CAPACITOR for that homebrew project? We may have what you need at more than 50% below regular amateur net. Send for free flyer. A.R.C. Sales, 181 E. Wilson Bridge Road, Worthington, Ohio 43085.

LINEAR BUILDERS: 100 MFD @ 3000 VDC Condensors, $30 each. Basil J. Weaver, 1821-C Ave. M., Lubbock, Texas.

HANDBOOK DESIGNS. Kits for construction projects appearing in Ham Handbooks and Magazines. 144 MHz FM Transmitter $59.50. 100 watt VHF amplifier $34.50. Low noise FET Converters $24.50. Pre-amps, $14.50. FET VFO $34.50. Others, free list. Midwest Communications, 101 E. Healey St., Champaign, Illinois 61820.

BRITISH COLUMBIA: The 1969 Okanagan International Hamfest will be held on July 26 & 27 at the Dollyn Varden Auto Court, Okanagan Falls, B.C. Registration time 11 a.m., Saturday. Further information write: Clarence LaBounty, Secretary treasurer, P.O.Box 551, Oliver, B.C., Canada.

FOR SALE: Eico 753 with VFO conversion, 752 power supply, mike, and Hustler 80-40-20 meter mobile antenna, $225. Don Cook, R.R.#1, Norfolk, Nebraska 68701.

SCOTCH COMPUTER #489 magnetic tape, 1" on metal reel (2) @ $5. Topaz C1OWDG 250 watt mobile p.s., $50. Hygain 12AVQ, $12. FOB. Richard M. Jacobs, 4941 Tracy, K.C.M.O. 64110.

SELL: GLOBE **KING** 500A, excellent 700 watt SSB linear – $125. Knight R100A plus T-60, both good condition – $100. Offers considered. WA4UNN, Box 221, Toccoa, Georgia.

VIDICONS, RCA 7735A–$20, RCA 7038–$15, Toshiba 7038–$10, Vidicon Yoke & Focus Coil–$35. WB2GKF, Stan Nazimek, 506 Mount Prospect Avenue, Clifton, New Jersey 07012.

TELETYPE–SELL: Gears, paper, cranks, motors, non-overliners, 28 TR's, KSR, ASR. GR syncronometer. Wanted: M.28 typing units (any condition), keyboard perforators-reperforators, bases, all unused parts. Typetronics, Box 8873, Ft. Lauderdale, Fla. 33310.

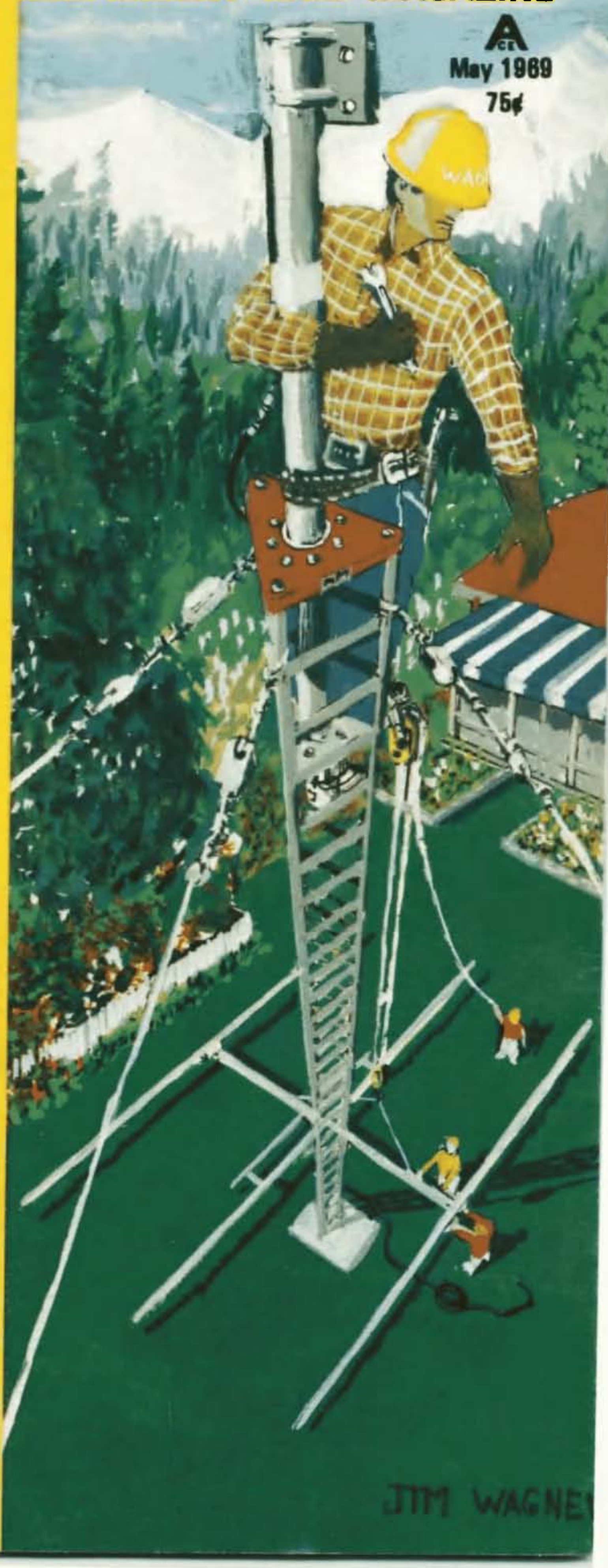
FANTASTIC-1969 New England ARRL Convention May 24 & 25, Swampscott, Massachusetts. Save money! Early bird registration $10 including Saturday dinner, dance and night club entertainment. Be a winner! Every major manufacturer will exhibit plus top speakers from science & industry. Tickets: W1KCO, John McCormick, Berkeley St., Taunton, Massachusetts.

WORLD'S LARGEST INDEPENDENT HAM MAGAZINE

AMATEUR RADIO 73

May 1969

75¢



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73 MAGAZINE

73 Magazine #104, May 1969 Contents

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...de W2NSD/1

Wayne Green

Just where does amateur radio stand today? And, where is it going? Obscenity on our bands...disenchantment with the ARRL... also with the FCC...worry about the ITU...the Miller 'effect' on DXing...home brew dying... movements to CB-ize our hobby...our empty Extra Class bands...growth of the hobby stopped...major manufacturers leaving or left for CB money...terrible QRM on a few bands ...wide open emptiness on others...clubs lanquishing...etc. Do we have more problems than we can solve? And, who is to solve them?

Let's briefly look at our background and then try to see where we are today.

The beginnings in any field of discovery are left to the amateur. The first radio amateurs were experimenters who built a good deal of their own equipment for the fun of it and got on the air with spark transmitters and fought QRN and, eventually QRM. Amateurs, naturally, were responsible for a lot of the important developments. As radio communications became a bigger and bigger business the ham bands shrank accordingly and more of the developments were made by larger companies who could afford the research engineers and expensive equipment required for the work.

By the late 20's commercial receivers were becoming popular and fewer and fewer amateurs took the trouble to build their own. Most of the amateurs built their own transmitters right up until WWII. This was because there were not enough amateurs to make commercial production of transmitters profitable at the time.

After the war there were so many surplus transmitters available that there was little incentive to go out and buy parts for building a new rig. With Command Sets selling for $5 which, with a little conversion, would give 100 watts of very stable VFO power on most ham bands, one would have to be crazy to spend $100 or so on parts to build the same rig. I remember buying a 100 watt Jefferson Travis surplus transceiver which covered 160-80-40 meters, AM phone and CW, a bunch of the Command Sets, SCR-522's galore, ARC-4's, a Meissner Signal Shifter, a BC-312 and an SX-28...all surplus and all of which I used for years. The Signal Shifter, with a little NBFM modulator I put in, connected to a pair of surplus 813's, let me work the world ...on all bands!

About the time surplus began to fade away our manufacturers saw that the ham market had grown big enough to make it worth while to add transmitters to their receiver lines. What ham in his right mind would go out and spend $200 for parts to build a rig that has no resale value worth mentioning when he could buy the same rig commercially for perhaps $250? A handful of amateurs continued to build their rigs, but they did it for the fun of building and had to recognize that economically they were in the hole.

Amateur construction did not die, by any means. Thousands of amateurs continued to build equipment...but now it was VHF gear which was not available commercially...RTTY terminal units...gadgets. Building projects in the ham magazines would often be duplicated by hundreds of readers. Probably only about 25% of the amateurs built equipment at this time, compared to the near 100% of the 30's.

Then came the transistor. Most of the older timers didn't even try to accommodate to the transistor. They went on for a year or two or even three building the tube circuits published in the magazines and ignored the transistors. As time went on fewer and fewer of those cartons of old tubes in the closet would fit into the new projects being published. Hardly anyone called for an old bathtub capacitor (condenser) anymore.

The percentage of home construction dropped. Most of the radio parts distributors went to selling complete equipment and CB rigs, leaving the parts jobbing to a handful of large mail-order houses. Gone was the day

(Continued on page 89)

Who's Who in Amateur Radio

Wells Chapin, W8GI
2775 Seminole Road
Ann Arbor, Michigan 48104

We have celebrities in our ranks. There are many illustrious and glamorous names in the Call Book. Oddly enough, however, despite their status in their various fields of endeavor, these well-known persons do not constitute an aristocracy within our midst. Far from it! For Amateur Radio, unlike other forms of activity, exemplifies true Democracy. It cuts across class lines with complete disregard for wealth, social standing, nationality and creed.

Many of our colleagues possess names which are universally recognized, and it is high time that we acknowledged their presence among us. At a point in time when we hear constant warnings that our frequencies are in jeopardy, we may help to preserve our allocations by generating a program of better public relations. It is certain that we can use a more positive image. And surely, publicizing the names and achievements of our more eminent and distinguished hams will tend to enhance that image.

There are hams in medicine, law, show business, the clergy, the military, Big Business, Government, foreign royalty, and two of us have even run for the highest offices in our nation.

Not because of established protocol, but because it seems a likely place to begin, here are some hams with the "Blood Royal" in their veins. P. T. Namgyal, King of Sikkim, operates from the Palace at Gangtok as AC3PT. He has an American wife, who probably complains about the unsightly tower and beams which disfigure the looks of the house, just as ours do. OE3AH is Archduke Anton von Hapsburg, the Austrian pretender. Moulay Hassan, CN8MH, is King of Morocco. In Saudi Arabia, where Ibn Saud, who was probably the last of the absolute monarchs in the world, operated as HZ1TA, three of the Princes hold ham tickets. Crown Prince Abdullah is HZ1AF, Prince Talal uses the late King's call, HZ1TA, and Prince Saud ibn Saud was HZ1SS. So much for the blue bloods.

I wonder how many who have visited that famous landmark in New Orleans, Antoine's, realize that it is owned and operated by Roy Alciatore, W5RU. Roy loves to QSL, and he usually sends a commemorative Mardi Gras medallion along with his card.

Many DX'ers are familiar with the call, UA1LO. Sad to say, this ham is now a Silent Key. He was the Soviet Union's intrepid Cosmonaut, Yuri Gargarin. Incidentally, it is being rumored that one of our own Astronauts, who is a ham. may operate a rig on a forthcoming moon snot. It is said that the operation will be on the 144 MHz band.

Here are several hams who have achieved stature in the entertainment world:

Arthur Godfrey	K4LIB	Radio & TV personality
Tex Beneke	KØHWY	Band leader
Bill Leonard	W2SKE	Radio & TV announcer
Alvino Rey	W6UK	Band leader
Harry Gumm	K6MDD	Circus clown
Mel Shavelson	W6VLH	Screen writer, producer
Andy Devine	WB6RER	Famous character actor
Dave Mann	K2AGZ	Songwriter of many hits
Bob Mersey	W2TXI	Recording producer, conductor
Ernie Lehman	K6DXK	Film writer (Sound of Music)
Julius Baker	W2TDY	lst Flutist NY Philharmonic
Paul Weirick	K6AK	Arranger (Lawrence Welk)
Jean Shepherd	K2ORS	Humorist, Radio personality
Luz Zuluage	HK6LT	Miss Universe 1959
Pee Wee Hunt	W1AYA	Famous jazz musician
Cliff Arquette	ex W6SGP	Charlie Weaver
Freeman Gosden		Amos
Bobby Byrne	WB2JDG	Trombone, record exec
Wilmer Allison	W5VV	US Davis Cupper

While we're on the subject of entertainment, 8XK, the ham station of Frank Conrad, later became known as KDKA. This station in Pittsburgh, was one of the pioneer stations in the crystal set days, and many's the hour spent manipulating the old cat's whisker, trying to pull in KDKA, back in the 20's. Really, the broadcasting industry owes its very existence to hams, for they laid the groundwork and experimented independently so that the principles of radio broadcasting could become a practicality. Prior to their work, radio was used solely for the communication of messages. The concept of broadcasting music, sporting events, Presidential Inaugurations, and such, was strictly the brainchild of hams.

Incidentally, there are many firms which make ham gear whose proprietors hold tickets. Art Collins, WØ CXX; Frank Gunther, W2ALS; Percy Spencer, W1GBE; Parker Gates, W9DZT, and many, many others. Bill Halligan, W9AC, founder of the Hallicrafter Corporation, was one of the founding fathers of our hobby, and deserves special mention.

Here are some outstanding business people who are amateurs:

Cyril Staud	K2DQ	Vice Pres., Eastman Kodak
Harry Vickers	W8HBY	Pres., Sperry Rand
Herb Scofield	W8DBH	Pres., TMC Systems
Buzz Reeves	K2GL	Reeves Sound Studios, etc.
George Davidson	K6EI	Exec., Standard Oil
E. Henderson (dec'd)	W1UDY	Exec., Sheraton Hotels
Harold Churchill	W2ZC	Exec., Time Publications
Bill Newcomb	K2CNX	Insurance Exec.
Harold Carlson	W2UNR	Exec., Associated Press
Findley Carter	K6GT	Director, Stanford Research
Bob Waters	W1PRI	Pres., Waters Mfg. Co.
Carl Lindemann	W1MLM	Vice Pres., NBC
Bob Ehrlich	W2NJR	Exec., AT&T

General Electric has over 1000 hams, and there are hundreds at RCA, Westinghouse, Bell Telephone and others. Ford Motors has a ham club with over 100 active members. There are amateurs in all sorts of industrial and commercial institutions. Banks, department stores, railroads, shipping companies, utilities, airlines, mining and smelting companies, steel and copper firms, newspapers, book publishers, advertising agencies, drug firms, oil producers; these are just a few categories of business where hams may be found.

The clergy is well represented. Father Dan Linehan, S.J., of the Weston Observatory, W1HWK; Father Tom Aquinas Cox, W2CBX, of the International Radio Mission Association; Father Chuck Tardiff, 5H3 Jack

Rabbit, and Father Moran, 9N1 Mickey Mouse, are some of the more well known ones. And there are countless priests, nuns, ministers and rabbis, chaplains, and at least one Greek Orthodox priest, all yacking away, even as you and I.

Many of us remember the sinking ship, Flying Enterprise, whose skipper refused to leave, even after he had ordered his crew to abandon ship. His gallantry made headlines all over the world. This was Kurt Carlson, W2ZXM, who can often be heard on 20 meters, operating maritime mobile from the seven seas.

The president of Louisiana State University is John Hunter, W5DTL. W1DDB is the reknowned sculptor, Allison Macomber. And, Bill Juhre, the syndicated cartoonist is W9IMQ. Ray Blosser, W8DBK, is vice president of a bank in Cleveland. We've got 'em all over!

Politics and the Diplomatic Service are not without hams.Of course, we all have heard of K7UGA/K3UIG, Barry Goldwater. Some of the less publicized ones are:

William Porter	K1YPE/XV5	Dep. Chf. of Missions in Viet Nam
Maurice Bienbaum	HC2KX	Ambassador to Ecuador
Armin Meyer	OD5XX	Ambassador to Lebanon
Dudley Mason	KW6CJ	Governor of Wake Island
Bert Delotto	W6FGY	California Legislator
James Homes	W6REK	California Legislator
John Doughten	W3LV	Pennsylvania Legislator
Carl Ruh	W4TZT	Kentucky Legislator
Frank Hazelbaker	W7FTP	Montana Legislator
John Thompson	W7OAZ	Montana Legislator
John McCarthy	K1EMO	Former Comm'r of Finance, Mass.

There have always been many hams in the military. Since communications are a vital link in the successful maintenance of a proper military establishment, it would be difficult to envision a situation in which there were no reasonably close relationship between the Defense Department and Amateur Radio. In times of crisis, we are expected to furnish a pool of experienced communications personnel, upon which the military can depend. This calls for some degree of liaison.

Some of the high ranking officers who who hold licenses are:

Rear Admiral H. Bruton	W4IH
Major Gen. Elmer (Bill) Littell	K3BNI
Gen. W. W. Watts	W4VI
Admiral McCarley	W6BSH
Admiral Weatherwax	W4PDW
Major Gen. Shuler	W4KN
Gen. J. Smith	W6RT
Adj. Gen. Windom	W8GZ
Gen. Joe Stillwell, Jr.	W4FPE

The history of Amateur Radio, indeed, that of electronics in general, is star-studded with many great names, each of which would be entitled to an individual article; their contributions have been so significant. Men like DeForest, Colpitts, Hartley, Meissner, Armstrong and Hazeltine, all hams, have given the fruits of their genius for the betterment of all humanity. Without the work of these pioneers, many of the marvels which make life easy today would not even exist. It is fair to say that these men were giants.

Thanks to the devotion and dedication of thousands of radio amateurs, the art of electronics has contributed greatly to world peace and friendship. Nations, once widely separated from each other, have been enabled to maintain lines of communication and avenues of peaceful approach.

International aspects of ham radio may generate further interchange, resulting in an atmosphere of genuine amity and good will among the nations of the world. It may spread out to the general populations, and finally reach up to the ruling circles. In this way, ham radio has an opportunity to make its greatest contribution of all. Hams everywhere have a justifiable reason to be proud of their hobby. There are few hobbies which are so capable of contributing to society.

...W8GI

A Stacked Gamma Matched Turnstile

Glenn H. Chamberlain, WA9LPC
4822 Prospect Avenue
Downers Grove, Illinois 60515

Having just acquired the desire to operate on the higher frequencies, I purchased a conventional two-meter rig and an eight-element commercial yagi antenna. It was immediately apparent that the local groups were impossible to copy readily using the highly directional antenna.

In reviewing the material in the usual handbooks, the stacked turnstile appeared to be the most promising compromise. However, the need to insulate the elements from each other, and the matching, seemed overly complicated.

Why not a gamma match eliminating the need for insulators? The elements were cut from 3/8 inch aluminum tubing for the center of the band, 146 MHz. Their length from the formula for a half wave dipole is 38 inches.

With the gamma match the elements could be bolted directly together to a common boom. Using number 14 wire, the gammas were connected 4 inches from the center connection of the elements running horizontal ½" above each element towards the center.

To provide a 90 degree phase shift between the elements of each turnstile, use a quarter wave section of RG-58AU. The half wave sections for 146 MHz, using the 0.66 velocity factor, is 26.6 inches for each. The entire antenna is then fed at the center of the two half wave sections with RG-58AU.

The antenna was hung about four feet off the side of the tower at the forty foot level. The feedline at this location is about 75 feet long. A 15 watt AM transceiver was used for the test. The standing wave ratio was 1.3 at 144.4 MHz, 1.2 at 146.0 MHz, and 1.3 at 147.6 MHz.

The band was open when the antenna was connected. Reception of an Iowa station about 145 miles distant from Chicago dropped one S-unit when shifting from the commercial eight-element beam to the home brew turnstile. In comparing my signal with this station, my signal also fell one S-unit when changing from the commercial antenna. If the commercial beam lives up to its specifications of 15.5 dB gain, this means the stacked turnstile has about a 10 dB gain on a long haul.

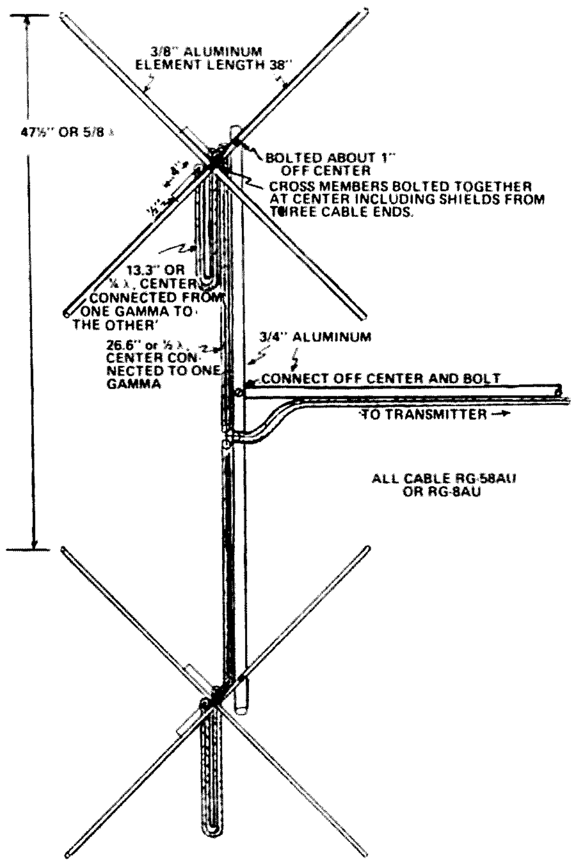

Fig. 1. The Stacked Gamma Matched Turnstile.

The antenna had excellent transmitting gain when using it in local group communication. Receiving was not quite as good. However, if more gain is desired, there is no reason two or three of these stacked turnstiles could not be hung around the perimeter of tower, each turnstile being fed with half wave sections of RG-58AU cable.

This antenna is simple to build, cheap, light, omni-directional and required no tuning after fabrication. At this QTH, we highly recommend it for those "local" schedules, and on the longer hauls you might be surprised.

...WA9LPC

The VHF Vacation Special

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Dauphin Island AFSTA
Dauphin 15, Alabama 36528

For years I have been associated with the theory of using a simple whip or wire antenna and pumping as much power into it as you can to work as far as needed. This, of course, is a necessity if high mobility required for military communications is to be achieved.

With this background I found that for amateur operations this usually didn't work if you want a highly portable, cheap but efficient vhf antenna system.

The whole idea was to build an antenna from materials at hand in the average home. Using this premise a covey of antennas ranging from ground planes, verticals and simple beams were constructed out of metal coat hangers; collinears from aluminum clothes line and even the TV log periodic when re-runs were the only thing available to watch.

The latest, which is discussed here, was built out of some aluminum foil I scrounged from the XYL. (She is WA2YXE and it sure helps when you start taping the foil to the walls).

The "slot" antenna in its basic configuration of a plane surface is not usually used in either amateur or commercial applications. Commercially the slot antenna has been in use for several years, but, as in the case of navigational systems such as TVOR, four cylindrical slots are rotated electrically to obtain an extremely accurate circular radiation pattern.

Some basic theory of the slot will be needed if a practical antenna is to be built.

The slot can be considered a length of shorted open transmission line one-half wavelength long, so the standard current, voltage and impedance curves apply as seen in **Fig. 1**.

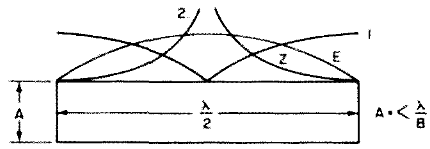


Fig. 1. Basic slot antenna.

The simple slot is nothing more than a ½ wavelength by .15 wavelength rectangular hole cut in a sheet of metal. The width of the slot is small at the higher frequencies, but with current flowing over the entire surface of the sheet (both faces) and not restricted to the slot edges, the capture area of the antenna is extremely large.

The interesting point is that if the slot is cut vertically to the ground reference **(Fig. 2)**, the antenna will be horizontally polarized and conversely horizontal slots **(Fig. 3)** are vertically polarized due to the development of the "E" fields of the antenna.

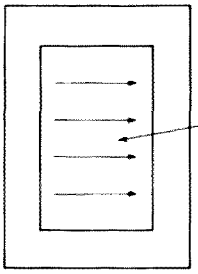


Fig. 2. Horizontal polarization.

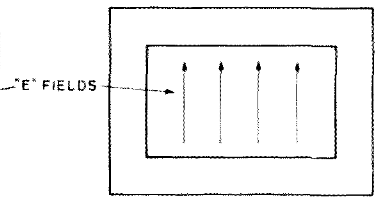


Fig. 3. Vertical polarization.

RG-8 or RG-58 coaxial cable can be used to feed the plane surface "slot" antenna even though the nominal center terminal impedance of a resonant ½ wavelength slot in a large metal sheet is in the neighborhood of 500 ohms. Feeding the slot with the 50

ohm coaxial cable off center will offer a fairly close impedance match between the feedline and the slot. The theoretical distance from either end of the slot is 1/20 wavelength, but the exact point must be found experimentally for each installation as surrounding structures offer some change to the impedance characteristics. The "Rule-of-thumb" is to start at the 1/20 wavelength point and work both ways until an optimum match is achieved.

The aluminum foil "Slot" antenna is the ultimate of simplicity in construction as can to be seen from **Fig. 4.**

The figures in Columns A & B were computed from Length (Inches) = 5905/Freq (MHz) and will work as is, but the figure in Column C must be found thru trial and error. I found that the distance from the end computed for 1/20 wavelength worked better from the middle.

For the best operation some method of bonding the coax to the sheet is necessary. I found that transparent tape can be used with little or no loss of power transfer if the tape is tight over the coax conductor and shield where it comes in contact with the sheet.

After construction of the slot antenna you should have something that looks like **(Fig. 5).**

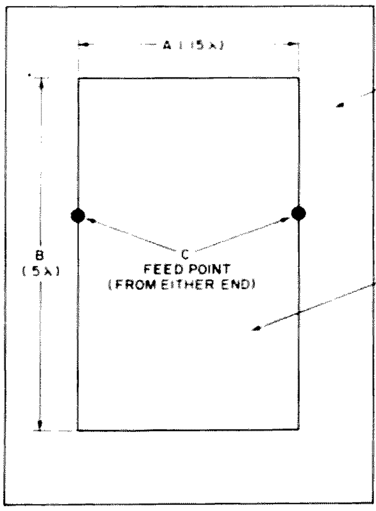


Fig. 4. The VHF Vacation Special. 65" sheet of 18" wide aluminum foil (a). (b) using chart 1 for measurements, and a single edge razor blade, cut out center piece and discard.

Freq MHz	A Inches	B Inches	C Inches	Distance from end I used.
144.0	12.30	41.00	4.10	17.40
144.5	12.26	40.88	4.09	17.41
145.0	12.23	40.75	4.08	17.42
145.5	12.18	40.60	4.06	17.43
146.0	12.14	40.45	4.05	17.45
147.5	12.08	40.29	4.03	17.47
147.0	12.04	40.13	4.01	17.49
147.5	11.99	39.98	3.99	17.51
148.0	11.95	39.83	3.98	17.52

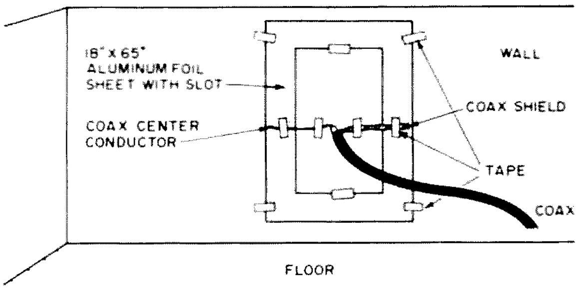
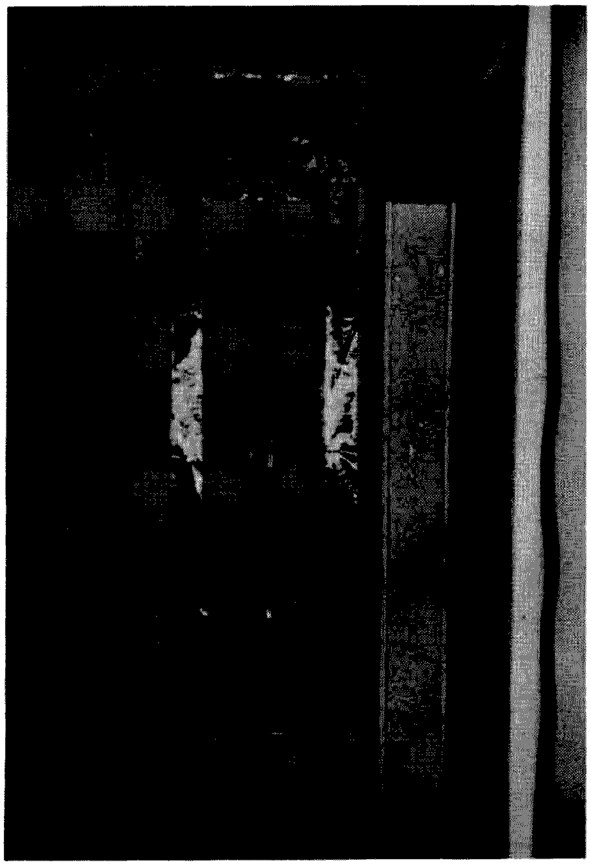


Fig. 5. Complete slot antenna. If mounted on a door it can be rotated to cover all directions.

The two major lobes of this antenna will be through the slot, perpendicular to the plane of the sheet. As seen from the top of the antenna (see arrow in **Fig. 5**) you can expect a pattern similar to that shown in **Fig. 6.**

If this antenna can be mounted on a door



144.OMC slot antenna, horizontal polarization.

near the transmitter, rotation of the pattern will be possible. It was found that by swinging the door 90 degrees signals that were a clean S-9 dropped sharply to below S-4.

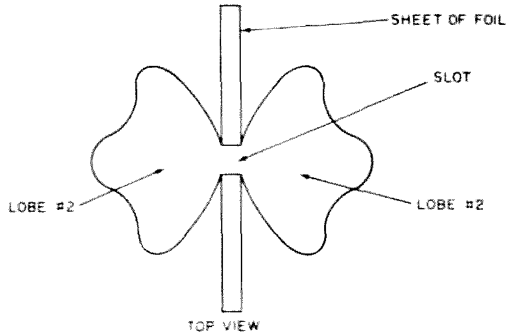
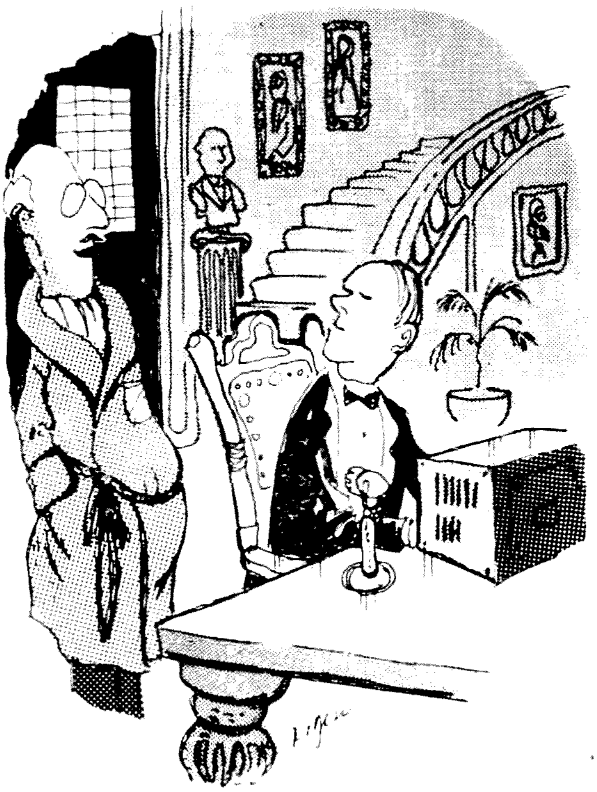


Fig. 6. Top view of radiation pattern of the slot antenna.

This antenna has out performed everything built to date including a ground plane at 25 feet above ground and the TV log periodic at 50 feet above ground. Reports have been exceptional up to 25 miles on the 143.950 MHz MARS frequency which is good on the Mississippi coast. Super regen receive such as the "Twoer" are completely quieted at 15 miles with less than 5 watts fed to the slot.

...W2ZRX



"Allow me to tune, Roggs—I need the exercise."

"S" Unit Attenuator

Edward A. Lawrence, WA5SWD/6
218 Haloid
Ridgecrest, Calif. 93555

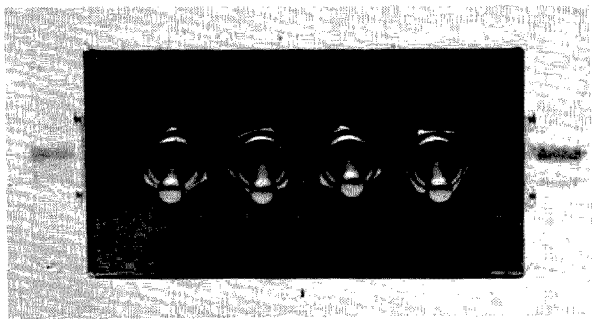
Since the topic of "S meters" is a popular one among radio amateurs, a lot of time is spent describing these devices, usually along the lines of how generous or "Scotch" the meters are at the QTH of the parties in the QSO. After a few such QSO's, I decided to build an attenuator, calibrated in "S" units. My aim was to attain an accuracy of 1 db or better, using 5% ½w resistors and simple construction so it would be easy to duplicate. What I wound up with is very similar to the attenuator described on page 40, January '67, 73.

As a sidelight, I started out by calculating both "tee" and "pi" pads, and used "pi" because all values of resistance are close to standard values, but (especially for high attenuation pads) the values for "tee" pads can get quite small; and expensive.

I figured the values required from the tables in the Allied's "Electronics Data Handbook", page 8, 5th edition. (Allied Radio, 75c, full of good info.)

Since "S" units are supposed to be 6 db, I figured data for steps of 1,2,4 and 8 times that amount, or 6,12,24 and 48 db. With these steps, any number from 0 to 15 "S" units of attenuation could be selected. However, 8 "S" units proved to be too much for one step, as shown by the lowered attenuation at 30 MHz, due to the inherent shunt capacitance of the resistor used in the series leg, plus the stray capacitance of the switch. So I removed the 8 "S" unit step and installed another 4 "S" unit step. This allows selected steps of attenuation from 0 to 11 "S" units.

Here are the values I calculated, and the actual values used, based on 51 ohms. The steps are switched in series, as required for the desired attenuation.



Front panel showing the switches for the various steps of attenuation.

Resistance Values for 51 Ohm Attenuator:

		R1		R2	
"S" units	DB	ideal	actual	ideal	actual
1	6	154	150	38	39
2	12	85	82	96	100
4	24	58	56	405	390
8	48	51.5	51	6400	6800

After the attenuator was completed, the attenuation was measured at 3 kHz and at 30 MHz. With the test equipment available it was possible to measure more accurately at 30 MHz than at 3 kHz. Below is the data from the tests.

Atten Step		Predicted	Measured	Measured
"S" units	DB	atten DB	at 3 kHz	at 30 MHz
1	6	6.2	6.0	6.02
2	12	12.3	12.2	12.16
4	24	23.3	24.2	24.05
8	48	48.5	47.5	39.11

Now if we want to make an educated guess as to how far up we can expect good results, say 1 db error out of 24 db, then we can use the measured error in the 48 db step to calculate the capacitance across the series leg, and from that calculate the frequency where the 1 db error will occur. Go through the math if that is how you get your kicks, or take my word for it. It comes out to about 2 pF. And this will cause a reduction of 1 db at about 220 MHz. And since the resistor is

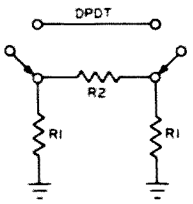
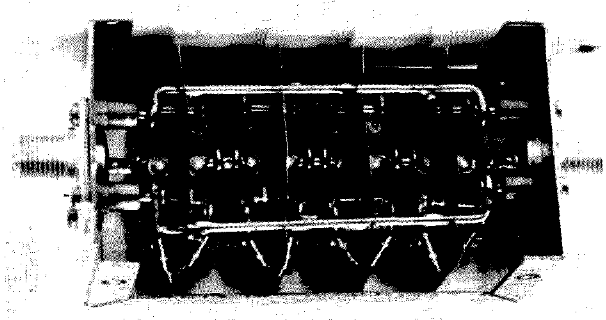


Fig. 1. Diagram for one step in the attenuator.

of a lower value for the smaller steps, they should hold their values to even higher frequencies, but I expect other factors would get into the act along the line somewhere. I will state that still works well at 2 meters.

If you want to get fancy, you can always figure the values for 1, 2 and 3 db steps and have from 0 to 72 db attenuation in 1 db steps.

Referring to the photos; you can see I built my attenuator in a Bud Minibox CU-2102-A, 4" X 2-1/8" X 1-5/8". Four steps is the maximum in this size box, unless different switches are used. Mine are Cutler-Hammer 7592K6. The shielding was made from transformer strap, but could be any soft copper available. Try a Hobby Shop and get the thin sheet that is used for embossing if all else fails.



Looking inside the attenuator.

Here are some of the uses an attenuator of this type is suited for:

Checking receiver "S" meter calibration.

Attenuating signals to aid in peaking receivers and converters.

Calibrating diode voltmeters for *rf* measurements.

Checking antenna gain. Or gain of that outboard *rf* stage.

P. S. My "S" meter lies, just as I thought!

. . . WA5SWD/6

Armed Forces Day, May 17

Contacts may be made on CW with WAR (Washington) on 4001.5, listening 3.5-3.65; 4020, listening 3.65-3.8; 6992.5, listening 7.0-7.1; 7325, listening 7.1-7.2; 14405, listening 14.0-14.2. NSS (Washington will be on 3385, listening 3.5-3.65; 7301, listening 7.1-7.2; 14400, listening 14.0-14.2; 21500, listening 21-21.25. NPG (San Francisco) will be on 4005, listening 3.5-3.65; 7495, listening 7.1-7.2; 13975.5, listening 14.0-14.2; 20954.5, listening 21-21.25. AIR (Washington) will be on 3397.5, listening 3.5-3.8; 6997.5, listening 7.0-7.2; 13995, listening 14.0-14.2; 20994, listening 21-21.1. Times are 171400Z to 180245Z.

SSB contacts may be made with NSS on 4040, listening 3.8-4.0; 7336, listening 7.2-7.3; 14385, listening 14.2-14.35. NPG will be on 4001.5, listening 3.8-4.0; 7301.5, listening 7.2-7.3; 14356, listening 14.2-14.35; 21600, listening 21.25-21.45. AIR will be on 4025, listening 3.8-4.0; 7305, listening 7.2-7.3; 14397, listening 14.2-14.35.

RTTY contacts may be made with NSS on 4012.5/3.65-3.8; 7380/7.0-7.2; 13940/14-14.1. NPG will be on 4016.5/3.65-3.8; 7347.5/7.0-7.2; 13922.5/14-14.1. AIR will be on 3347/3.5-3.8; 7315/7.0-7.2

Watch for a plane flying between Washington and Boston on 143.82, listening 144.0-145.5 on AM and RTTY. Also one flying between Los Angeles and Seattle on 143.7, listening on 144-148 AM. Mt. Diablo will be on 148.41 on AM/FM/RTTY, tuning 144-148.

CW Receiving Contest

At 180300Z (2300 EDT, 1900 PST) May 17th at 25 wpm, there will be a special Armed Forces Day message on WAR on 3347, 6992.5, 14405. On NSS on 3385, 7301, 14400, 21500. On NPG on 4005, 7495, 13975.5, 20954.5. On AIR on 3397.5, 7315, 13995. On A6USA on 6997.5.

RTTY Receiving Contest

At 180335Z at 60 wpm WAR will transmit the message on 3347, 6992.5, 14405. NSS on 4012.5, 7380, 13940. NPG on 4016.5, 7347.5, 13922.5. AIR on 3397.5, 7315, 13995. A6USA on 6997.5. A5USA on 4025.

Send entries to Room 5A522, Pentagon, Washington, D.C. 20315, before 31 May.

In the Beginning...

Bob Manning, K1YSD
915 Washington Road
P. O. Box 66
West Rye, New Hampshire 03891

Not long ago – 'twas October 3rd, 1968 to be exact, I was pouring L.S.D. into the air conditioner – I had taken an overdose of Midol barely 28 days previously and was morosely ruminating over the plight of the radio amateur. I remember the date very well. It was the fifth anniversary of ARRL's first Incentive Licensing proposal to the F.C.C.

Since we were about to 'gird our loins' and march valiantly back into yesteryear to the 'golden' or 'good old days' I had just ordered a 1936 Hudson Terraplane, dusted off all my old Rudy Valley records, bought up enormous quantities of lamp wick trimmers, pinned on my Alf Landon and Wilkie buttons and started building a two-holer replete with quarter moon, corn cobs and Sears Roebuck catalogs.

I was looking forward to going backward and seeing horse drawn carriages, apple carts, bread lines, WPA workmen and the return of spats, bustles and cholera.

Without warning, I was seized by *'holographitis'* which is similar to *'inspirational graphitee,'* but occurs outside water closet areas: 'tis an uncontrollable urge to write – something! – somewhere! I immediately seated myself and pounded out an article entitled, "Ipecac Works on Lids" (73 magazine, November 1968).

The response to this article was overwhelming! The fact that 'both' letters were written on foolscap with crayon and in block letters made little, if any, difference.

The Editor of 73, upon securing my release from the Intensive Care Unit of the local Domicile for Dememted Ding-a-Lings suggested I write more articles of similar ilk.

In the coming months and subsequent articles, I shall – by drawing on a seemingly bottomless pit of banality – endeavor to look at the foibles, follies and idiosyncrasies of amateur radio in such a way as to be humorous and satirical without being offensive.

If I am to be thusly foisted upon you, it is only fair that – like in *high class* books – you receive a resume' of my bona fides. 1. how had I become a ham and 2. what had put me on the path of *'holographitis'* besides a case of 'hoof and big mouth' disease and a diarrhetic typewriter?

How had I become a ham? Ah yes, I remember it well. Like most things I do, I did it backwards. Most hams become interested in amateur radio and then get their license. I got my license and only then did I become interested in amateur radio. This statement requires some explanatory background.

I spent 9 years in the U.S. Navy as a radioman and then, after a short stint with a British Thermal Unit (that's a hot one!), I transferred into the Air Force (ours). While I was in the Navy, I was considered an idiot

by those whom I thought were of high intellect. In the Air Force, the exact opposite was true. To this day I haven't figured out whether 'tis better to be thought an idiot by genuis' or a genius by idiots . . .

This variance of feelings was not, in reality, without basis. For, when I entered the Navy, it was with the understanding that I would be schooled as a Hospital Corpsman and study under the famous Doctor Chicago, who was doing experimental research in 'acne' and 'hickey' transplants. Unfortunately, the 'powers that be' discovered that I was color blind and, in their infinite wisdom, transferred me into Radio/Electronics – have you ever seen a color blind person trying to decipher the color code on a resistor? The process, like the mating habits of the penguin, is strictly 'trial and error' *(Incidently, the trial and error mating habits of the Penguin is probably the reason for that creatures universal disease, 'pknobophobia' (fear of backing into cold door knobs) and the most likely reason for their Charlie Chaplin-like walk and accounts for the fact that you never see a Penguin in a crouched or bent over position.).* This deficiency on my part led my superiors to look askance at my attributes. Combine this with my chubby, pear shaped appearance – which gave me the unique distinction of being the only man in the history of the U.S. Navy to ever wear a Bell Bottomed *Shirt!* and their feelings become understandable.

Of course, the fact that I once suggested replacing the old libido controlling saltpeter practice with a *'dry ice'* treatment did little to change their opinion. Instead of surreptitiously inserting saltpeter into the food fare, I proposed swallowing small dry ice capsules to freeze the prostate gland – thus arriving at the desired result without altering the taste of the food. Unfortunately, although the process did work, the side effects were nothing short of spectacular! It not only accomplished its original purpose, but also froze the larynx and the colon. The latter action created some extremely embarrassing situations for the user and the former action precluded him from calling for assistance.

Despite these obvious drawbacks – and the fact that I suffered from chronic seasickness, I became an excellent radioman. My last official test CW paper was accredited with 40 wpm. I must confess, however, that the officials simply took my word for my own test results. The tests had been given during heavy seas and the judges – to a man – exhibited a strange reluctance to either handle or even look at my paper.

Possessing the ability to send and receive CW at 25 and 35 wpm respectively and having trained on a great variety of electronic equipment, it was only natural that, when I transferred into the Air Force, that they would put me to work in a Teletype tape delivery center – where the only electronic mechanisms were a moldy coffee urn, a Tucker built coke machine and the ever present 'panic button'.

Eventually, however, I did end up in communications at a USAF MARS station where I made my first contact with the amateur radio fraternity. The Sergeant I worked for – call him Sam – held a 'Conditional' class license. Now, at that time, I knew nothing about the licensing structure and mistook the disdain shown towards Sam to be an aspersion on the type of license instead of the man. Whenever we held MARS meetings, the members flicked ashes in Sam's lap, lobbed candy wrappers at his Metrecal, accused him of having rubber pockets to steal soup and stated that, "if he had a brain, he'd be arrested for smuggling trash!"

Having no special love for Sam and being blessed – or cursed – with a caustic tongue – and knowing the disdain in which he was held, it was inevitable that we should eventually tangle.

It happened! - - - - One day, with Sam driving our 5 ton truck and with a burly airman seated between us, Sam managed to manually manipulate the controls of the truck in such a fashion so as to knock down two light standards, remove all the warning lights from the rear of the vehicle, open a new entry way into the MARS station, scare hell out of two pregnant dependents and caused the airman to slide, in a kneeling position, downward and forward under the dashboard where he straddled the drive wheel lever with considerable force – leaving him with a strange falsetto voice that may well have given rise to the eventual popularity of Tiny Tim.

Recognizing an opportunity to insert a verbal barb, I leaned across the agonized airman and asked, "Hey Sam – you got a 'conditional' drivers license too?"

There is no ire quite like that of an aggravated NCO and Sam was no exception. He immediately turned apoplectic vermillion, let out a 15 minute non repetative string of expletives and jammed on the brakes – once

again doing injury to the already anguished airman on the floor who, looking up at us with ƆMƆ blazoned across his forehead and, in a voice pitched somewhere between Jeannette MacDonald and Yma Sumac said, "fer cripesakes! ya dummy! you do that one more time . . . my navel's gonna look like a chin cleft and I'm gonna be wearing my truss for love beads!"

The final outcome of this incident was that Sam and I made a hot headed $5 bet that we'd both have General Class tickets within 30 days. Even though I managed to obtain mine in 28 days, I was unable to collect. The Air Force, learning of Sam's unique ability as a truck driver, had transferred him as an instructor to a heavy equipment school. There I was–I had a ham license and didn't know what to do with it.

Since that time, I guess I've progressed normally through the various stages of 'being a ham'–I began thinking up witty 11 meter type phonetics for my call sign, designed and scrapped hundreds of provocative QSL cards, progressed into the short purposeless QSO "hi there–I'm Bob– – broken old bottles – ur five nine – opps chow call – c u l" then gravitated into the public service field where I was prepared to battle my way through wind, rain, snow, sleet, hurricanes, typhoons, hippie uprisings, draft card burnings and other similar disasters to deliver *the* vital message thereby saving countless lives and millions of dollars and be awarded the 'purple clavicle' with 'oatmeal clusters.' I then took up the contest type operation– – "yeah, let's see – if I multiply my input power by the number of stations, add 5,000 for delivering a confirmation to the SCM, divide by the temperature, subtract 10% for being an appliance operator, add 127 points for having read the CD bulletin, figure the logarithmic value of pi R square (pie are square???? NO! pi are round–fig newtons are square) ah....ta hell with it– – – I'll cheat. I then settled down to appreciating and happily indulging in all areas and, to paraphrase Will Rogers, "I never met a ham I didn't like!" – Eventually, I reached the epitome of all hams.... writing sarcastic letters to ARRL.

This covers HOW I became a ham.... now, how had I sunk to the depths of satirical writings??

(International Business and newly formed countries want our frequencies, zoning laws restrict antenna heights, neighbors ogle us uneasily with awe – or fear – as if they expected us to mumble some voodoo chant, do two back flips and an arabesque, snip a lock of hair, sprinkle them with dried octupi eyes or dandruff and transform either them or ourselves into a 'fried egg sandwich'. TV viewers assail us for supposedly screwing up their twenty-one year old $37 Japanese TV set with the bamboo antenna and, on at least one occasion, hams became the topic of controversy in – of all places – an advice to the lovelorn column, our Mothers think we're gonna blow up the world – or at the very least – the house and our wives wish we'd forsake amateur radio for more sensible practices like 'bulb snatching' or 'skydiving' or become peeping toms, or winos or study the abnormal sex life of the African Anteater.)

Being a student of Zen, Extratenialism and intensely adroit at deep analytical introspective soul searching – which, literally translated, means "I goof off a lot!" – I have given considerable thought to this status. I have concluded that objective humor – satirical, distorted or prismatic is about the only thing that keeps me from running, stark naked, out of the house attacking the first AT&T truck I see and grabbing my neighbor by the throat, standing him on tippy toe and driving him into the ground with the motor end of a sump pump.

There are, of course, other alternatives that a ham may use as a relief valve. Among them is the process (which is becoming more and more popular) of submitting random proposals to the F.C.C.

I know of one radio amateur whose demented half brother, Alf, submitted a proposal within the past week. Alf, being the offspring of a neurotic and psychotic (those mixed marriages never seem to work out) and as an impartial outsider has rather an objective view. He submitted what, in the light of some of the more recent events, seems to be a palatable system for future Incentive Licensing.

Alf's suggestion is that all amateurs be immediately reduced to Novice class and issued new licenses combined with a fixed amount of marbles secreted in a cummerbund. (choice of colors – marbles and cummerbund – is optional). As the operator operates, he must assume anatomically impossible positions – like standing on his head with one foot stuck out the nearest window – a G.I. can may be fastened 6'6" above the floor as an effective substitute –

(Sometimes, when I make like an SWL, I'm not absolutely sure that this procedure is not already in effect)—In this way, the operator must manage to loosen the marbles from the cummerbund. His operating privileges will be inversely proportional to his supply of marbles. This will continue until he reaches the pinnacle; i.e., the highest grade of license and the 'loss of all his marbles'! Note...Alf submitted an addenda suggesting new classes of license— —I don't know them all, but they run something like this: (a) the Dummy class (b) Novice (c) Apprentice (d) Mediocre (e) Mundane (f) Technician (g) Adequate (h) Advanced (i) Improving (j) Extra (k) $_{\pi}\Sigma{=}\ \pm\div\_\,^{-}\cdot\pi{+}{=}^{32}$ and the (l) Whoopee class...

One item I feel I should inject to round out my resume' is the fact that I am quite vain. Besides being large of girth and tired of fun being poked at my expanse, I was once totally bald.

Because of that hairless state I paid a thousand dollars for a complete 'Follicle Graft'. (The operation, for the uninformed, is the transplanting of hair and roots from a volunteer donor to the top of the head of the recipient).

Regretably, in this case, the grafter used the hair from the hind leg of a German Shepard and, since the operation, I've fallen in love with a State Trooper, have a constant craving for ALPO, my backyard is pockmarked from my inept attempts at burying bones, I can't stop chasing cars and every time I pass a fire hydrant, the whole head of hair snaps straight up!

I hope you will find some enjoyment in the articles. Even though I once thought 'verbiage' was verbal garbage and 'sagacity' implied some physical malformation, writing is not a new thing with me. I am the author of one article entitled, "Where Are The Men?" it dealt with the poignant question 'where is MR. PAUL, UNCLE JEMIMA and WHISTLERS FATHER?? – I then wrote a ditty titled, "   on the Range" and, finally, I am putting together an amateur radio study book to be called, "I'VE UPPED MY OPERATING PRIVILEGES .... NOW ....UP YOURS!!!!!"

Friendliness and Courtesy are contagious . . . start an epidemic (K1YSD)

Don't Kill Your Generator!

Jim Ashe, W1EZT

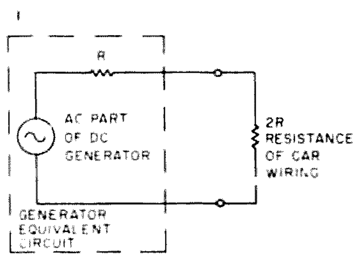
Going to filter out that noise from your car generator so that you can better enjoy your mobile rig? Careful, or you may kill your generator, too. It's been known to happen.

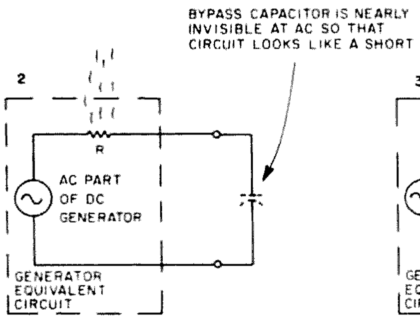
Since generators put out dc, it seems reasonable that a little old capacitor (or a little new one) across the output shouldn't hurt anything. But it's a fact the output is something more than pure dc, or you would not be thinking about filter capacitors. Now, when you put a capacitor across the output you are shorting all that hash, noise, and ac that the generator makes, straight through to ground. Are you sure you want to do that? See Fig. 1.

All dc generators are really ac generators. You don't see the ac because it's rectified at the commutator. But the commutator doesn't do a perfect job, and there is some sparking there too, so that there is a lot of noise power available at the generator terminals.

In normal generator operation most of this power is dissipated in the car's electrical circuit, which has a fairly high resistance compared to the generator resistance. But when you put that capacitor across the generator's output, while the dc is not affected, all that noise power is now dissipated inside the generator – right in the armature, as illustrated in Fig. 2. If the generator is working hard anyway, perhaps during mobile operation, the increased dissipation may be enough to push it over the edge. Result: you buy a new generator armature.

But it's not hard to avoid that trouble, if a filter capacitor is needed. What if you add a small resistor in series with the capacitor? See Fig. 3. Now the ac is still provided with the relatively easy route across the generator terminals, but less power is dissipated since circuit resistance in increased, and most of the power goes into the outside resistor where it does no harm. You get your filtering, and the generator survives. Try it this way, next time!





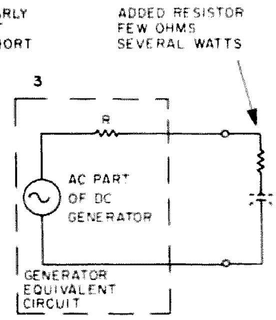


Fig. 1. Equivalent circuit at ac of an automobile generator installation. Resistance of car wiring is probably larger than that of generator by a factor of 2 to 5.

Fig. 2. If the car generator terminals are bypassed with a good capacitor, they are shorted so far as ac frequencies and noise are concerned. With reduced resistance greater currents flow, and the ac energy dissipated in the armature is several times greater than under normal conditions. At heavy generator loads the armature may deteriorate rapidly, or be destroyed.

Fig. 3. The simple solution. A small resistor added in series with the capacitor reduces currents and carries much of the ac dissipation outside the armature. A few ohms should be appropriate, and checks may be made by temperature observation or direct measurement of armature noise and ac currents.

Working DX Without Six Elements

Joseph E. Taylor, K5PAC
6 Evergreen Court
Little Rock, Arkansas 72207

Obviously, you won't work as much as often as the fellow on top of Crow Mountain with six elements, wide space, on a 100-foot tower and a 2 KW rig.

But you and I have already learned to adjust to that fact of life in our every day competition with the "big sigs".

The point is – you can work a surprising amount of DX of all sorts with Q5 QSO's if you go at it right.

Many American hams do not venture into the DX portions of the bands because they feel that they are not well enough equipped to work any DX. It ain't necessarily so!

So you have only 90 watts and no beam and very little chance of improving either – you can still work DX and enjoy it.

Maybe we ought to ask, "what we mean by DX", since not everyone means the same thing.

Old Charlie on the mountain has nearly 300 countries confirmed now. To him DX is another new country. "So what's another MP4 if you already have cards from each one that counts?"

But to most of us DX is that unique satisfaction that is associated with calling a fellow ham in another country, whether 3,000 miles away or 10,000 miles around the globe, and hearing him come back with that sweet sound that is our own personal private call! And the thrill is apt to be all the greater if we are operating with what we know to be less than the ultimate in equipment. A VQ9 on a beam or a quad is satisfying to be sure, but on a dipole there is an added dimension to the enjoyment.

By this I am not advocating that you use anything less than the best combination of equipment and antenna you can muster. The six element beam is wonderful if you can swing it, but my point is, you aren't out of the running if you can't.

A word needs to be said about what is meant by "working" DX too. For some fellows it is an exchange of RST, QTH and 73's. For others it involves a greater degree of getting acquainted as person with person. Where you will want to find your own maximum satsifaction is up to you alone.

Admittedly, it is harder to maintain a DX contact than it is to get one. So your percentages go down as your time in QSO goes up. In effect each of us works out his own pattern here.

CW or fone? Again we have to look at plain facts. Your chances with lower power and/or simpler antenna systems are better on CW than on fone. A good receiver can dig out and render copyable an extremely weak CW signal that would be hopelessly buried on SSB, let alone AM.

So, if you can do so enjoyably, you will have improved chances of success in CW operating. Don't be overly worried if your CW isn't perfect and your speed is down. DX operators are among the world's best at matching speeds. You will find fast ones and slow ones and very nearly all of them are patient, so don't chicken out on this score.

O. K., so you are ready to try – now for some concrete suggestions which will improve your chances of success.

1. Check your rig thoroughly. The fact that your power is limited doesn't mean your efficiency needs to be.
   A weak driver tube may not make much difference in rag-chewing in the 75 meter net. It may lose you many contacts in DX operation. Try to make sure your transmitter is at 100% peak of efficiency. Make sure your signal is clean and well keyed. Whatever your final power rating, you don't need to lose any unnecessarily.
2. Go over your receiver with the same kind of thoroughness. Any tubes that even leave you in doubt about their condition should be replaced. More contacts are lost because of inadequacy in receivers than in transmitters.
   If your receiver could profit by the added gain and the improved signal-to-noise ratio of one of the newer

preselectors, it is a fine investment.
If your major problem is lack of selectivity, you may receive a good deal of help from a Q multiplier.
If your receiver is not stable it can be fatal in DX work. The inclusion of VR circuits or some approach to maintaining a fairly constant temperature in the receiver may help. Separate switching which leaves the heaters on at all times is a simple approach to this.

3. Give your antenna system a chance to do its best. Make sure it is the best you can arrange for a given DX band.
If the system is not rotatable, try to orient it toward your favored direction (s). For example, in the central United States a dipole oriented NW/SE will favor both Europe and Australia. The direction of a dipole won't matter tremendously, but take whatever advantage you can get.
Remember that the longer your wire, assuming it and the line are tuned, the better.
Make sure your feed line is the best you can get. Coax may be your easiest approach, but compared to open wire line it is not as efficient.
A tuner is not a necessity, especially if you use coax, but it will more than repay you for your effort and cost in building or securing one.
4. Listen – Listen – Listen. Spend hours on the bands you are interested in just listening. See what bands are open when, and to what parts of the world. Find out what parts of the DX bands will likely be best for you.
For instance, you may find less crowding around 14,075 than around 14,010. For a signal which has its limitations you may do better there even though you hear more DX on the lower frequency.
5. When you are going to call a DX station who is calling CQ, be ready to call the instant he signs. If you drag your foot and hear another station calling him you probably won't call at all. Assume that the same will bé true of others. Get in fast.
Don't call too long. After repeating his call twice and your own twice, break and see if he heard you. If he isn't answering, try two more of each. This is much better than four repetitions to begin with.
6. Calling CQDX. Don't be afraid to do it but don't overdo it. Remember your signal needs an opening more than repetition. Try to find a little gap between signals. Call QRZ once and sign your call. If there is no response call CQDX twice and your call twice and K. No more.
No fancy stuff – no "AR-K" – no "DX pse KKK". In general the DX boys are good operators and they will respond to good practice on your part.
7. Answering. When you get a response keep your first transmission very short. . . . perhaps . . . .
XY9AA De K5PAC – R – GM OM ES TKS CALL UR RST 559 – 559 QTH LITTLE ROCK ARK – NAME JOE – HW – XY9AA DE K5PAC – K
There is little point in repeating what he got the first time, so unless his signal is very weak, keep your repetitions to a minimum. He will want his report, your QTH and your name. The rest can come in later transmissions. Get your first round completed, then get acquainted, if conditions permit, and your friend wants to. If he wants a short QSO, fine, keep it short. Your last transmission can be friendly without wishing "73's, 88's, gud luck, best DX, and gud health" to each member of his family individually.
8. QSL'ing – If either of you really wants a QSL then be prompt about it. If not, "pse QSL" is not an essential part of a QSO. He won't have his feelings hurt if you don't ask him for one. If you actually want it, O. K. If not, why put him to the trouble and expense?

This article is written to convince the ham – maybe *you,* if you've read this far – that fun can be had in the DX aspect of our hobby even without kilowatts and beams.

This is not speculation nor theory. In the past we have had quads and beams and I thoroughly believe in them. But in our present QTH the very best I could come up with was a 100 foot long dipole fed with open line into a home brew tuner. The rig runs about 180 watts CW.

Frankly, I've had a ball working DX on 15 and 20 meter CW. Why not crank up your rig, oil up the key and join me some day soon?

. . . K5PAC

The Short-Vee Antenna

Edward M. Noll, W3FQJ
3510 Limekiln Pike
Chulfont, Pennsylvania 18914

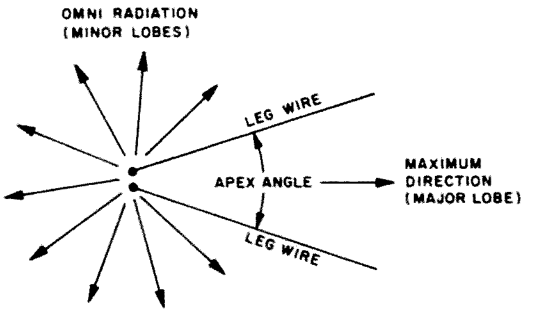


Fig. 1. The Short-Vee Antenna.

The short-vee antenna is an effective fixed-position antenna because of its reasonably omnidirectional pattern plus a broad directional characteristic in one direction. A simple definition for a short-vee antenna would be a vee antenna with a leg length of no greater than 100 feet or no greater than 2½ wavelengths, whichever is the shorter. Angle between the two leg wires would fall between 60 and 100 degrees, **Fig. 1.** If the legs are dimensioned and trimmed carefully, such an antenna requires no tuner and permits direct feed to the coaxial line between antenna and transmitter.

The short horizontal vee antenna should be made resonant on the desired bands. Do so by making certain the legs are an *odd multiple of an electrical quarter wavelength.* Equations for determining odd quarter wavelengths are:

$$1/4 \text{ Wavelength} = 246/f_{mc}$$

$$3/4 \text{ Wavelength} = 738/f_{mc}$$

$$5/4 \text{ Wavelength} = 1230/f_{mc}$$

$$7/4 \text{ Wavelength} = 1722/f_{mc}$$

$$9/4 \text{ Wavelength} = 2214/f_{mc}$$

The practical electrical quarter wavelength of the leg is somewhat shorter than the above formula values. In most instances for a short horizontal vee mounted at least 30 feet above ground, the shortening is approximately 6%. It is advisable to cut the legs long and then cut back slowly to the desired frequency using an antenna noise bridge or swr meter. When using an swr meter it is essential that the meter be placed a *whole multiple of an electrical half wavelength* from the point where the transmission line is connected to the antenna.

Multi-Band Relations

An interesting relationship exists among the odd quarter-wavelength dimensions for various amateur bands. For example the leg length for 5/4 wavelength operation on 15 and 7/4 wavelength operation on 10 is approximately the same. Thus a compromise leg length can be determined that permits optimum operation on both bands, **Fig. 2.** Furthermore an additional leg can be added in conical fashion to obtain an odd quarter wavelength operation on still another band.

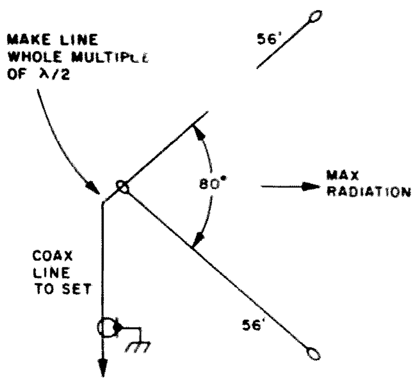


Fig. 2. The 10-15 Short-Vee.

Matching is helped by using a compromise length of transmission line which is a whole multiple of an electrical half wavelength on each band. In so doing the antenna resistance is reflected to the transmitter with little or no reactance. Thus the SWR ratio can be kept below 1.8 to 1 without any tuner at antenna or transmitter. This expedient permits fast band changes.

10-15-20 Short Horizontal Vee

Still another advantage of the short vee antenna is its limited space requirement. A practical version of this antenna style is

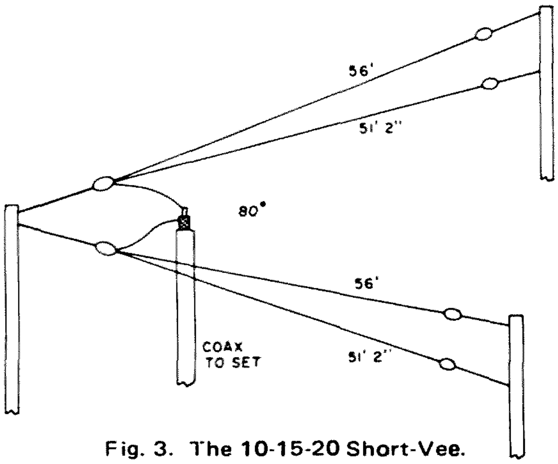


Fig. 3. The 10-15-20 Short-Vee.

given in **Fig. 3**. It serves as a fine antenna on 10-15-20 meter sideband. One pair of legs is cut to 56'. In so doing resonance is established on both the 10 and 15 meter bands. The second pair of legs is cut somewhat shorter to 51'2", operating as a 3/4 wavelength resonant leg on 20 meters.

The two pairs of legs are brought together at the apex and connect to the coaxial transmission line. The legs fan out from this point in conical fashion, **Fig. 3**, and have a separation of approximately 10 feet at the far end.

The apex angle was made 80°. The total length of transmission line from antenna to transmitter can be made any whole multiple of 45 feet. (The 45-foot figure takes into consideration optimum operation on the three bands and the velocity factor of 0.66.)

A line that bisects the small angle of the vee is the direction of maximum radiation. For the short vee antenna it is quite a broad beam. At the same time there are additional lobes that provide omnidirectional radiation as well. Thus the antenna support positions can be selected to obtain maximum radiation in some preferred direction at the same time you can obtain acceptable all-direction radiation as well. It is not a high gain antenna but does give you that extra boost in some preferred direction.

Along the east coast such an antenna could be erected with its maximum direction south toward South America. At the same time it would provide good omnidirectional stateside coverage. If you have a WAS need, the maximum direction can be toward the west. At the same time you would have good north and south coverage. You may wish to beam it toward Europe, always ready for good openings. At the same time you have good stateside coverage.

. . . W3FQJ

The Little Wonder

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Every new QTH for the typical ham brings its own antenna problems. Returning to college to pursue additional graduate studies brought the age-old problem of how could I affix an antenna to a college dorm and not come under the watchful eye of the college authorities? The "Little Wonder" and an antenna tuner was the answer to my problem.

The basic idea came from an AFMARS antenna presently being used by some of the Texas members. This antenna is a normal 40-meter dipole with a coil at each end. The coil consists of 197 turns of No. 12 nyclad wire, close wound on a one-inch stock. It is tuned with a 48-inch pigtail which tunes 3311 kHz with a 1:1 SWR, with the ability to have a full-size 40-meter dipole for 7305 and the amateur use as well. (1 inch equals 50 kHz on the pigtail.)

The "Little Wonder" gets its name from the fact that it is a little wonder that the "Little Wonder" works. My first contact on 40 meters was a W3 in Pennsylvania, with a barefoot KWM2 at ten o'clock on a Saturday night and with the "Little Wonder" leaning against a wall in the kitchen location of my "ham shack."

Construction is simple and all parts can be purchased locally:

1 3/4" hard drawn copper tubing 31½" (junk yard, Sears, etc.)

1 3/4" hard drawn copper tubing 43 3/4" (junk yard, etc.)

4 6/32 1" brass bolts and nuts

1 36" oak dowel rod (fir will work, but oak is stronger)

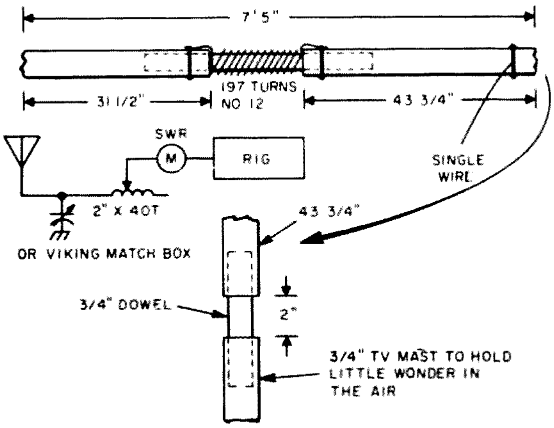
1 roll of plastic tape

1 55 feet of No. 12 nyclad wire (motor rewinding shop)

1 single-wire feedline to run from Little Wonder to antenna tuner...I used 8', 33', and 59' (when it comes into the room it could be hot with *rf*, so use a rubber or plastic coating on this section). I have found the 59' to work best with the Little Wonder about 35' up on top of a TV mast; however, at school the Little Wonder sat on the window ledge—so who knows?

2 3/4" bar stool rubber feet

1 24"x1" plastic water pipe to cover coil after assembly



The Little Wonder

How to construct: Drill a small hole in the wooden dowel 8" from one end. Twelve inches of No. 12 nyclad wire is pushed through the small hole. One person holds the 55 feet of No. 12 tight, and the second person starts turning the dowel rod until 197 turns have been made. A second hole is then drilled, and the other end of the No. 12 wire is put in this hole. Friction and the bend of the wire holds the coil in place. The dowel-coil assembly is pushed into one end of the 43 3/4" tubing, and the other end of the coil is pushed into one end of the 31 3/4" tubing. A 6/32 hole is drilled through the tubing and dowel and a 6/32 bolt makes a mechanical connection of the tubing to the pigtail of the coil. A third hole is drilled opposite the coil in the end of the long tubing, one inch from the end. A 6/32 bolt is placed in this hole for the single-wire feeder to be attached. The over-all length of the Little Wonder is 7'5". Rubber bar-stool feet are then placed over each end of the Little Wonder to keep out the weather, and the coil section is taped for the same reason. Attach your feedline and work the world.

How to tune the "Little Wonder": The best method of tuning the rig is to tune the unit into a 50-ohm load and then connect the antenna tuner. (Do not tune the rig.) The antenna tuner is tuned for 1:1 SWR. (A Viking Match Box will work fine; or make your own.)

How does it work? I am on the air with a lone KWM2 from 3311 kHz to 28 MHz, and without it I'd be QRT for the nine-month period. Trust you will be on the air soon with your own "Little Wonder." ...W5ZBC

Easy Tuning of the Multi-Element Quad Antenna

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Perhaps the most perplexing and one of the most controversial problems facing the builder of the multi-element quad is element length or tuning. There are many various articles on quads each having an individual formula for element lengths or method of tuning and matching transmission line to driven element. Basically, there appears to be two methods of approach. Compromise tuning for broad banding or "on the button" tuning for maximum efficiency over a smaller bandwidth.

Since 1958, when I first erected a four element quad, many, many man-hours have been spent making measurements with receivers several miles away, field strength meters, vswr meters, impedance bridges, and grid dip meters. At that time, there were no fiberglass poles, mounting hardware, or any other information available on multi-element quads. It became necessary to find a more or less foolproof method of tuning and matching for maximum energy transfer, with a minimum of effort and with equipment available to the average ham. With these points in mind, I set out to find that method.

Several methods were tried over a period of time. In each case, the vswr over the entire band looked good from the transmitter end—with one exception—the driven element was always reactive. It should be well known that the reactive component of *any* antenna, whether inductive or capacitive, does *not radiate*, in addition, the standing waves along the transmission line are not at the same point as they would be with a pure resistive load mismatched to the transmission line in the same degree although reactance is also measured in ohms. The proximity to surrounding objects does not affect the closed loop of the quad as much as it would a yagi type antenna. Work may be done on the quad much closer to ground level (15-20 feet) if allowance is made for a frequency rise of approximately 25 to 50 kHz at 14 MHz when the antenna is put back to forty feet or higher. Therefore, the quad should be tuned to a lower frequency to eventually come out at the design frequency unless all tuning is done at the final antenna height.

One factor that may be difficult for some, is that all elements must be made accessible. If not accessible from your tower or pole, a temporary 2x4 may be set in the ground high enough to put the boom of the quad at least fifteen feet above ground level. An allowance of 50 kHz should be made at this height. Should the diamond configuration be used, a slightly higher temporary pole would be necessary. From my tests there has been no noticeable difference between the diamond or the square configuration. Some may argue that the two high current points in the diamond configuration, being farther apart, would tend to increase the gain. Theoretically, this may be true, but no measurable difference has been noted here.

Let's take an example of a twenty meter four element quad in the square configuration to be tuned to a design frequency of 14250 kHz. Tuning to be done at a minimum height above ground. First, one must buy, beg, borrow, or build the following equipment: grid dip meter, vswr meter, antenna scope or impedance bridge, and one friend a mile or more away. The station receiver, of course, is also a must. You may use any of the convenient formulas as a beginning because in this case we are not interested in the length of wire as measured in feet and inches, but the results as measured by our equipment. It is always better to have more wire than needed as it is quite easy to cut off any excess. Some use number 10, 12 or 14 solid copper wire, some aluminum clothes line wire, or seven strands of number 20 or 22 plain old antenna wire; which is available at most all wholesale houses. There are now many construction articles on multi-element quads so we will not delve any further into that region.

String the wire and place all elements on

the boom, shorting all loops so that you have completely closed loops. No transmission line is attached as yet. Grid dip the driven element to approximately 14200 kHz. You need not try to be too accurate at this point. Attach your 52 ohm coax to the driven element and to your receiver. Now have your friend transmit a weak signal at 14200 kHz. Adjust the reflector element for a minimum signal from your friend's transmitter. You will note a definite null on the S meter of your receiver as you tune the reflector. A small stub of six to eight inches may be left for final adjustments. Cut off all excess wire, leaving the stub shorted. An electricians "bug" does a fine job as a shorting "bar."

Now let's insert a 52 ohm vswr bridge at the feed point of the driven element. Turn on your exciter at the lowest power possible to get a full-scale reading on your vswr meter. Adjust the driven element length for minimum reflected power. This reading will probably not go to zero reflected power due to the inductive reactance introduced by the reflector. Leaving the vswr meter "as is" at its minimum reading, adjust the first director (the one nearest the driven element) to further reduce the reflected power reading. This may or may not go to 1:1. If not, tune the second director in the same manner. The second director will have less effect than the first director on the reflected power. Proper tuning of the two directors with their capacitive reactance affect on the driven element will cancel the inductive reactance of the reflector leaving as near as possible a pure resistive load at the driven element. Remove the swr bridge and, using the antenna scope or impedance bridge, measure the feed point impedance. Should the swr meter have indicated zero reflected power upon completion of the tuning of all elements, the impedance measurement should have indicated 52 ohms nonreactive on the impedance bridge. In other words, the impedance bridge should null completely at 52 ohms indicating a nonreactive load. In the case of .1 wave length element spacing the impedance should measure about 50 ohms or lower. With .125 to .25 wave length element spacing between 50 to 75 ohms; .2 up to .3 about 75 to 100 ohms. Assuming that your impedance measurement came out around 52 ohms continue with the following. If the impedance is either higher or lower than 52 ohms, it is necessary to now use whatever matching method you prefer. Again an example: assume the driven element swr would not zero after all adjustments, and the measured impedance was in the neighborhood of 100 ohms. A simple quarter wave section of RG11U (75 ohm coax) may be attached to the driven element and all further adjustments made with the swr meter inserted at the junction of the 75 ohm quarter wave matching section and the 52 ohm coaxial line to the transmitter. Repeat the previous adjustments, starting with the reflector and the help of your friend, making only slight adjustments to the reflector as needed. All other adjustments should require only a "touch up." The above procedure is true regardless of element spacing as the phasing of parasitic elements is governed by the length of the elements for a given spacing.

Should the impedance be lower than the transmission line a Gamma or hairpin (Beta) match may easily be used. Refer to such articles or the handbook for adjustments, etc. Should the antenna impedance be larger than the transmission line use a quarter wave matching stub. The quarter wave matching section is preferred because of ease of construction. The Gamma or Beta match may also be used with the driven loop closed, but more time would be required for proper adjustment. The matching section is simply an electrical quarter wave transformer made from coax cable of a different characteristic impedance following as near as possible the result of the formula: The square root of the load impedance times the characteristic impedance of the transmission line. $Z_T = \sqrt{Z_L \times Z_S}$ where Z_T = characteristic impedance of the coax for the quarter wave transformer, Z_L = antenna or load impedance and Z_S = source impedance or the characteristic impedance of your transmission line. Should the load impedance be within a few ohms of 50, the transmission line may be connected directly to the driven element or through a one to one balun.

While the antenna is still lowered, make a bandwidth test with the swr meter at the feed point of the driven element or at the transmission line end of the matching section with low power fed to your transmission line from your exciter. Make swr measurements every 50 kHz and plot the curve on graph paper. Do not become alarmed if the swr rises very sharply at the low end of the 14 MHz band. The CW portion may still be used with the antenna tuned for the phone portion, although the efficiency does diminish. This is "on the button" tuning so the reactance will be negligable over the phone portion of

the band. If you use both phone and CW, it might be well to make the design frequency near center of the band. Likewise, the design frequency may be made in the CW segment if you desire. Getting back to the swr measurements, you will note that *at the antenna*, or the base of the matching section, if one is used, the reflected power is nil across the greater portion of the design frequency, making the *true* swr unit. Next remove the swr meter from the driven element and reconnect the transmission line. There is no need to cut the transmission line to any particular length—just use random length to suit your purpose. Insert the swr meter at the transmitter end next and again make the full swr meter measurements across the band every 50 kHz as previously done with the swr meter at the antenna. Again, plot the curve on graph paper and note the similarity of the curves. Due to a multitude of factors, the transmitter end of the transmission line swr readings will tend to be somewhat lower at the band end extremes.

A dummy load may be substituted for the antenna. Heath's "Cantenna" is a good and inexpensive one. The Waters dummy load power meter is excellent, but more expensive. An *rf* (thermo-couple) ammeter in the transmission line at the transmitter is worth its weight in gold and much more preferable to an in-line swr meter at the same point. Good Western Electric and G.E. *rf* ammeters may be purchased on the surplus market for less than five dollars. After tuning and loading the transmitter to either the dummy load or the antenna there will be no change in transmission line current when switched from one to the other and no retuning of the transmitter should be necessary. This indicates as nearly as possible with available equipment whether your antenna is nonreactive or near pure resistive. If a Bird Model 43 in-line wattmeter or equivalent is available, some interesting overall efficiency measurements may be made. Insert the wattmeter at the antenna feed point and adjust the transmitter to a given plate power input. On all further measurements keep the transmitter adjusted to the same power input. At frequencies near the design frequency the antenna is nonreactive and there is no reflected power and the overall efficiency is indicated. For instance, we adjust the transmitter to 500 watts dc input, the wattmeter indicates no reflected power and forward power reads 300 watts (with grounded grid amplifiers and 100 watts of power output from the exciter, the final amplifier should be adjusted to 360 watts input as the output from the 100 watts from the exciter should appear in the output to the transmission line). The overall efficiency from plate power input to actual power output to the antenna would be 60%. This includes normal transmission line losses, impedance transfer from final amplifier, etc. This percentage may seem high, but is quite attainable with good linear amplifier design and proper matching of transmission line to a resonant antenna. Now tune the transmitter to the same power, but to frequencies at which the antenna is nonresonant. Note the difference in forward power and reflected power. Subtract the reflected power from the forward power and figure the efficiency percentage. Make these same percentage measurements every 50 kHz over the band as was done with the swr curve. That does it! There lies the reason why it is still preferred to have an antenna with less frequency excursion and higher efficiency than one of a compromise nature.

The preceeding procedures are not intended to be the "ultimate" but will afford the "working ham" a less expensive and time-consuming method of getting the most from his multi-element quad antenna. Although the reference is to a four element quad on a thirty foot boom, the same approach may be used with a two or six element quad. The forward gain and F/B ration will be as good if not better than the average when tuned in this method.

Work has been going on for more than three years to broad-band a multi-element quad and yet retain a minimum reactive load over the entire band. Success seems just around the corner, but the last ten years working with the multi-element quad has taken its toll.

W4AZK

The Antennascope — An Effective Tool

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There are two types of antennas, commercial and amateur. A commercial antenna is generally designed for one frequency, has many acres of ground around it, no obstructions and miles of heavy copper cable buried underground to provide an "effective" ground. These antennas work as designed – very well. The amateur antenna, on the other hand, is just that – an amateur design and construction.

This antenna is subject to all ills, roof tops, buildings, trees, TV masts, house electric wiring, telephone wires and what not. It's a wonder they work at all! But they can be made to work and thousands of amateurs make them work. They make them work by pruning or lengthening the feeder cable and by using an antenna coupler. These are always empirical steps, the "let's cut and try and see what happens" method. How much better it would be, and a time saver too, if we tested our antenna systems electrically and *knew* what was happening and then could take intelligent action to put the whole antenna system into resonance.

This fact is well known – an antenna can only accept power and radiate properly when it is operating at its resonant frequency. This is no problem for the commercial people who operate at one frequency. The amateur, however, wants to "roam the band" and may wish to operate over frequencies hundreds of thousands of cycles wide, even megacycles wide. How can he do this with a fixed antenna system? The answer is, he can't! But he can construct an antenna system for a certain frequency and take the penalty of reduced radiation when he moves far away from it. However this actually works very well, because each amateur has his own particular part of a band in which he likes to operate – and his friends tend to stay there too. On this particular spot, the amateur works diligently to "put out a good signal."

The question arises – how can we make sure our antenna system is radiating well at the particulaf frequency we wish to use? One answer is to use electrical test equipment to show us what is happening on the whole antenna system, which includes the antenna and the feed line.

One of the most useful devices for this purpose is the *rf* bridge, generally called the Antennascope. Basic circuitry and values were described by WA1CCH in the January 1968 issue of 73 Magazine, page 21A. It is a simple device, inexpensive to construct and very effective in results. It is usually powered by a grid dip oscillator. Such bridges should be used at the junction of the feed line and the antenna and will show the resonant frequency of the antenna itself and the radiation resistance at the feed point.

Making such measurement up in the air is a difficult thing for the average amateur and impossible for those whose antennas are supported at the ends. If we are willing, however, to accept a small degradation in results, we can use the *rf* bridge at the station end if we have a half wave, or multiple of a half wave, feed cable. At every half wave point on a feeder cable the voltage and current vectors are in phase, which simply means that the electrical condition seen at the end of the cable is repeated every half wavelength in the cable. We can use the *rf* bridge then, at the station end of the feed line, if we are willing to agree that the results will not be 100% but reasonably close to it. The results will be affected by all the various factors that affect amateur antenna resonance and these effects may give us some peculiar results, but they can be overcome and the final results may be quite valuable to us.

Let me give you an example to illustrate what I'm talking about and to show you how effective the use of the *rf* bridge can be: –

A friend of mine constructed a 40 meter inverted V antenna, held at the feed point 40' up on his beam tower, 66' legs down to supports which held the ends about 8' off the ground. Feed line was 100' of Twin Amphenol cable, velocity factor .68. The antenna was difficult to feed, swr was high, radiation was poor. He asked me to have a

look (electrical) at it. I took my grid dip meter, *rf* bridge and vtvm.

The first thing done was to check the feed line length. 1/2 wave length at 7.1 MHz was 492 x .68/7.1 or 47.1 feet. Two 1/2 wave lengths (to get into the station) would be 94.2 feet.

The first conclusion was that the feed line was 5.8 feet too long.

Next Test No. 1 was made using the *rf* bridge with results as shown in **Fig.** 1, the results being shown in table form and also plotted in graphical form.

F MC	R OHMS
7.0	55
7.1	80
7.2	110
7.3	115

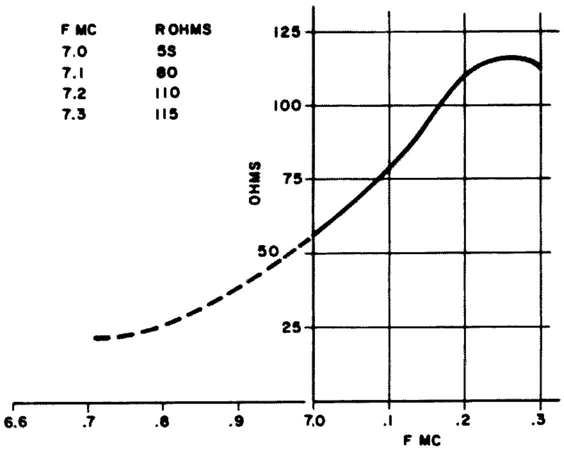

Fig. 1. 100' Feedline Test No. 1.

It was obvious from this graph that the antenna system was resonating outside the band as shown by the dotted lines. This test was repeated and the results were taken down to 6.4 MHz. They showed the system to be resonant at 6.6 MHz.

Test No. 2 was made next using the feed line cut to 94.2 feet. **Fig.** 2 shows the results.

F MC	R OHMS
7.0	48
7.05	51
7.1	69
7.2	80
7.3	115

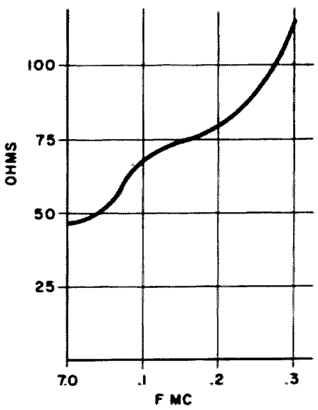

Fig. 2. 94.2' Feedline Test No. 2.

It was obvious the resonant point of the system was rising.

Test No. 3 was made next, cutting the feed line to 91.2 feet long. **Fig.** 3 shows the results.

F MC	R OHMS
7.0	43
7.1	48
7.2	78
7.3	81

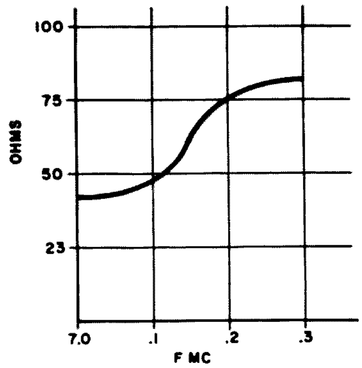

Fig. 3. 91.2' Feedline Test No. 3.

The resonant point was rising, but not far enough yet.

Test No. 4 was made using the feed line cut to 88.2 feet long. **Fig.** 4 shows the results. It was obvious that we were very

F MC	R OHMS
7.0	45
7.05	47
7.1	51
7.2	60
7.3	75

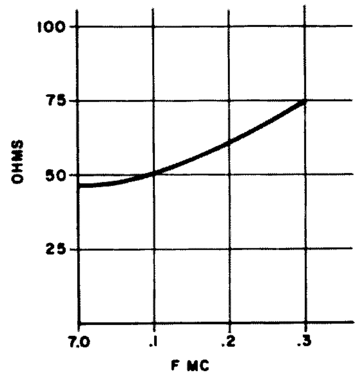

Fig. 4. 88.2' Feedline Test No. 4.

close to the resonant frequency of 7.1 MHz which my friend wished to use.

Test No. 5 was with 85.2 feet in the feed line. **Fig.** 5 shows the results.

F MC	R OHMS
7.0	78
7.1	61
7.2	60
7.3	66

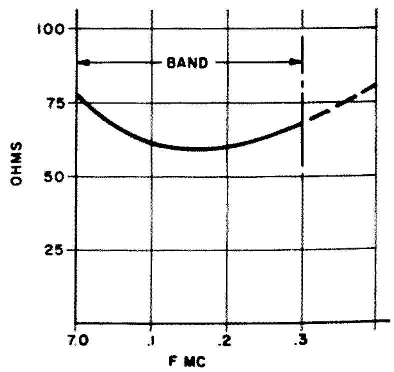

Fig. 5. 85.2' Feedline Test No. 5.

Test No. 6 was with the transmitter (300 watts CW) and antenna coupler connected. There was no trouble in loading and no trouble in balancing the coupler to obtain an swr of 1 to 1 ratio.

The results on the air were interesting,

5/9+ reports to the Eastern half of the U. S. A., 5/8 reports to Germany etc. *Conclusion:* The results shown above are not precise, nor can they be expected to be precise. There are too many unknown factors entering the electrical picture, such as those which required a shortening of the feed line, in this example, to somewhat less than a half wave length. But the bridge showed us the overall picture and suggested what was required to be done. The on-the-air results show that it was giving us a good picture and a result that was very satisfactory for my friend's needs.

Why not construct an *rf* bridge and check you own antenna system? I suggest it will pay off and be very informative to you, showing you what your antenna system looks like electrically and what to do to bring your whole system to the resonant frequency you wish to obtain. . . . VE3CEA

Short Cut to Matching

In building an inexpensive, short space, two element beam for twenty meters, considerable difficulty was met in obtaining an acceptable match from the feed line (RG-58) to the center coil of the driven element (link coupling method...ref. Radio Amateur Handbook, three element beam for twenty meters). The initial set-up is shown in **Fig. 1.**

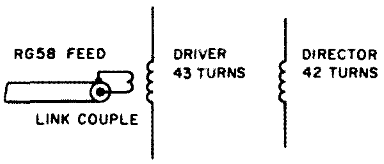

Fig. 1. Link coupling as in the original set up.

After initial tweaking, the best VSWR obtained was a disappointing 3:1. Varying factors such as changing the number of turns, spacing of turns and antenna height resulted only in *increasing* the VSWR.

Further thought and many aggravating trips up and down the ladder resulted in a decision to use an old approach to the problem by going to the "Gamma Match" method in Fig. 2.

The Gamma match was accomplished by:
1. Tying the shield of the RG-58 coax to the center turn #21 of the 43 turn center coil of the driven element and,
2. Connecting the coax center conductor to the 31st turn on the coil. This gave a starting point of 5:1 VSWR.

With a little hint from the handbook, a

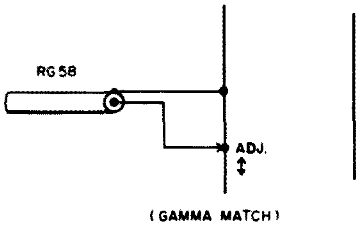

Fig. 2. Using the ever popular "Gamma Match."

140 picofarad capacitor was dug out of the "junk box" and inserted in the coax center conductor line...going to the tap on the coil as in **Fig. 3.**

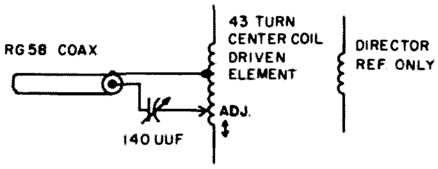

Fig. 3. Adding capacitor for best match.

The capacitor was set at several different positions and minimum of 3:1 was obtained at a max capacity setting. This appeared to be little headway for all the trouble, but past experience pointed to the possibility that the antenna height was a remaining variable not yet changed. A little experimentation with antenna height (more trips to roof) showed best results with it raised just five feet.

A check of the VSWR bridge showed a rewarding 1.5:1 for all our efforts to obtain a match.

Bernard Oliver, K6CZJ

DX QUIZ

OK, you DX'ers, how are you on prefixes? Score five points for each correct prefix. We are in Africa this trip.

Congo Republic	....	Republic of Guinea	....
Republic of the Congo	....	Uganda	....
		Rwanda	....
Mali	....	Niger	....
Central African Republic	....	Tanzania	....
		Gabon	....
Senegal	....	Spanish Guinea	....
Cabindi	....		
Fernando Poo	....	Mauritania	....
		Lesotho	....
Zanzibar	....	Mozambique	....
Chad	....	Botswana	....

You'll find the answers on page 50 No fair peeking until you've committed yourself to good guesses.

Two on Top

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Those of us restricted to using top-loaded verticals on 75-80 meters for fixed station operation, are apt to regret the narrow bandwidth inherent in this type of antenna. So it was with my Hustler 4-BTV, which performs fine over as much as 150 kHz in any selected part of the band, but limited my operation to either SSB or CW for a given adjustment. Since I like to work 80 meter CW DX and also ragchew on 75 meter SSB, there just had to be a better solution than lowering and raising the antenna each time I got a yen for the alternate mode of operation.

There was, and it was as simple as installing two top-loading coils—in my case the Hustler type RM-75.

This was accomplished by fabricating a suitable mounting bracket out of 1"x¼" aluminum stock, as shown in the figure. The two "ears," 45 degrees to the center mounting surface, permit the two coils to be mounted physically 90 degrees to each other, minimizing intercoupling. The bracket is mounted by the center hole to the 3/8"-24 stud atop the 4-BTV, on which a single RM-75 loading coil is normally attached. The stud

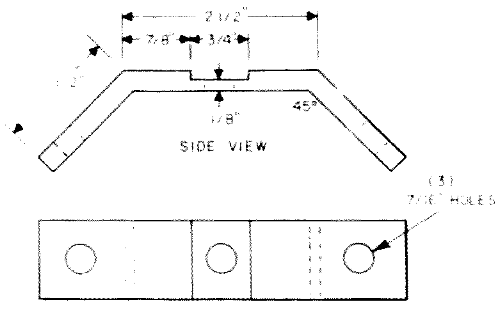
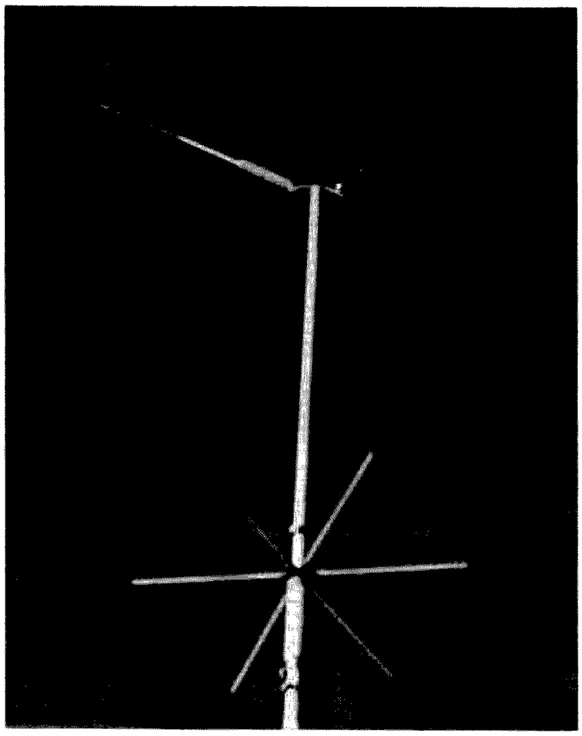


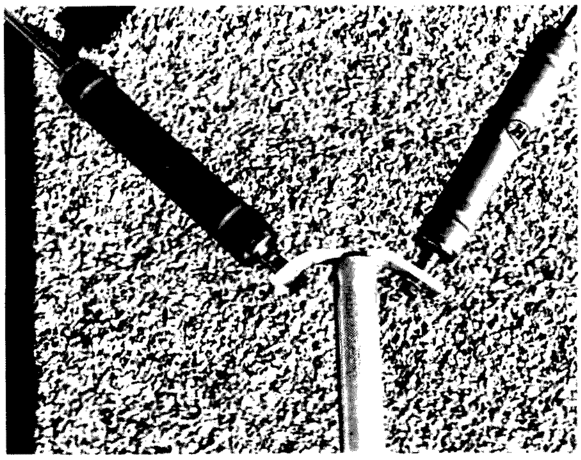
Fig. 1. The mounting bracket for two RM-75 loading coils.



View of the antenna in use.

being only about ¼" long required filing down the bracket thickness to 1/8" at the mounting point, in order to secure the bracket with a 3/8-24 nut. 1"x1/8" stock is also available, but it was felt this would be a bit flimsy, causing the "ears" to flap in a stiff breeze, with detrimental affects on resonance and loading. Anyway, both kinds of stock are to be found in the "Do It Yourself" aluminum rack in well equipped hardware stores. The coils are attached with 3/8-24x½" bolts using washers, plus a split lock-washer to take up the extra bolt length and ensure that the coils won't come loose.

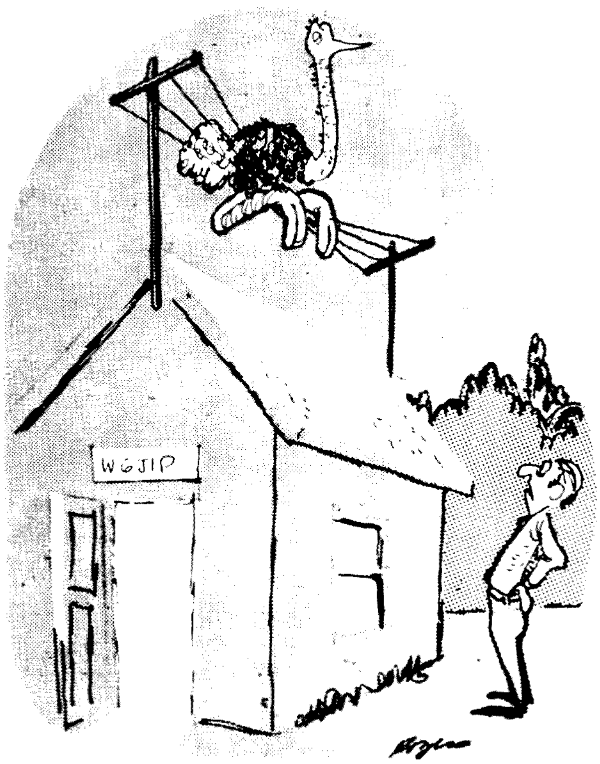
The pictures show the finished product. One coil is resonated by it's whiplet to 3900 kHz and the other to 3550 kHz. The antenna resonates and loads with low SWR at both frequencies with no interaction between the coils, and I can now enjoy operation on my



Mounting details showing the two "ears."

two favorite sections of the band without roof-climbing. The assembly easily withstood recent 55 mph wind gusts.

Of course, this principle can be applied to any similarly top loaded vertical, with a suitably made bracket. Hmmm! If I made a bracket with ears parallel to the mast, I could mount more than two coils, horizontally, and 90 degrees to each other, giving me additional band coverage. Who is going to be first on their block to have "four on top?" or even five? ...W6AJZ



"Blimey! No wonder I'm not copyin'!"

Measuring Antenna Gain

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Some basic methods are described for measuring antenna gain using a reference gain antenna as well as methods that can be used when a reference antenna is not available. Even for those who do not plan to use the methods described, reading and understanding them will provide a better insight into the meaning of an antenna gain figure. If one likes to experiment with antennas, either building arrays or experimenting with new forms, a continuing problem is how to measure the gain of an antenna. Of course, the proof of any antenna will always remain in how it performs in actual operation. Also, gain is just a number and by itself doesn't convey any information about the overall radiation pattern(except to say that it is formed in some directive manner). Nonetheless, it is often handy to be able to talk about some gain figure for an antenna.

One can estimate gain by using a new antenna in the same mounting position as an antenna of known gain and comparing many signal reports, switching back and forth between the two antennas, to obtain some reasonably meaningful gain figure for the new antenna. The procedure can be rather tedious, however. This article describes various ways by which the gain of an antenna can be more accurately measured, whether one has an antenna of known gain available or not. Because of physical restraints and the interference produced by atmospheric noise, the described methods work best with VHF antennas. However, with care, the methods can be used with well elevated high-frequency antennas. Another way to check the gain capabilities of a proposed high-frequency antenna design would be to first construct a scaled VHF model of the antenna. Such a model is also very useful to study the impedance and matching conditions necessary for best antenna performance.

Basic Method

Fig. 1 illustrates the basic equipment setup which is necessary to measure antenna gain.

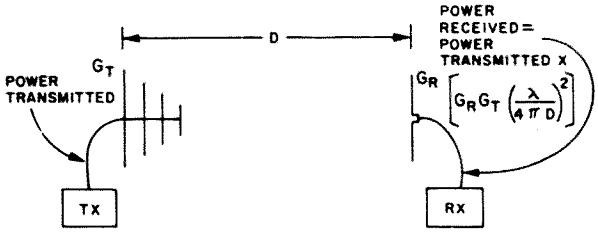

Fig. 1. Basic free-space transmission formula between antennas. Antennas are in the same plane and the transmission line between the equipments and antennas have negligible loss. Loss, if present, can be included as a scaling factor (i.e. a total line loss of 2.5 db will reduce the power received by a factor of .55).

The gain of the antennas and the power transmitted and received are related by the standard transmission equation:

$$P_{transmitted}/P_{received}=G_t G_r\ (\lambda/4\pi\ D)^2$$

G_t and G_r are the numerical values of the gain of the transmitting and receiving antenna, respectively. The term in parenthesis is simply a constant. λ is the operating frequency expressed in meters and D is the distance between the antennas also expressed in meters.

The above equation is true so long as the antennas operate with essentially plane wavefronts. That is, if the antennas are too close there will be an appreciable phase difference between the signal which one antenna receives from the center and the edges of the other antenna. So, for good measurements, D in the above equation should at least be equal to about $2L^2/\lambda$. L is the longest lineal length of the antennas being used and λ is the operating frequency. For instance, if an antenna were to be tested on 2 meters which had a maximum length of 3 meters, or about 10 feet, the test antennas would have to be separated by at least 9 meters, or about 30 feet. Generally, there is no difficulty in meeting the separation requirements unless one is dealing with very large antennas at very low frequencies.

The necessary power measurements can be accomplished in several ways. A wattmeter can be used in the transmitting antenna's

transmission line or the *rf* voltage across the line measured and the power calculated. The line itself should be operating as close to a 1:1 swr ratio as possible. The receiving antenna power can be measured in essentially the same manner or if the gain of the receiver is accurately known, it can act as a power indicating device. Again, the impedances between the antenna, transmission line and receiver input must be correctly matched. Still another method is possible if only the power output of the transmitter can be measured. The transmitting power is adjusted for some convenient reference level on the receiver (receiver avc is off). The receiver "S" meter, if it is the type that functions with the avc disabled, or an audio output meter, if the transmitter is tone modulated, can be used. The transmitter is then connected to the receiver and its output level slowly increased (using an attenuator network or by varying an operating voltage which controls the output power) until the same reference level is obtained. The power level required will be the same as the received power.

If one operates only on a specific VHF band and wishes to construct a sort of "instant reading" gain meter, this can be done by using a dipole as the receiving antenna and placing an *rf* rectifier circuit and meter directly at its terminals. As long as the distance between the transmitting antenna and the receiving reference antenna is kept constant and as long as the input power to the transmitting antenna (of unknown gain) is always the same, the meter can be calibrated directly in terms of antenna gain. It is only necessary to use several antennas at the transmitting end of known gain first in order to establish the calibration of the receiving antenna "gain" meter. Such a device can be a great deal of fun and use during competitions at field days, etc. for the best antenna designs. Aside from the distance and power considerations mentioned, however, the only requirement for the FD "wonder" antennas tested is that they be capable of producing near unity swr in the transmission line to the transmitter. Unless this condition is met, the "gain" meter readings will not be valid in either an absolute or comparative sense. The basis for the calibration of such a meter should become clearer from the following test situations.

Gain Using a Standard Reference Antenna

If one has constructed an antenna of known directivity gain and wishes to determine the gain of an untried antenna design, the setup of Fig. 1 can be used. The transmitter output power and received power are measured and the gain is calculated from the formula previously given, knowing the antenna separation and the operating frequency (using the untried antenna as either the transmitting or receiving antenna). For instance, if the reference antenna used is considered to have a gain of 1(0 db), the original formula can simply be restated as:

$$G=(4\pi\ D/\lambda)^2\ P_{received}/P_{transmitted}$$

Thus, if an antenna were tried on 2 meters at a distance of 10 meters and the power received were 1/10 of a watt for a 10 watt transmitter output, the gain would be:

$$G = (4\pi\ 10/2)^2\ \frac{1/10}{1/10} = 36 = 15.5 \text{ db}$$

This gain is in reference to the gain of the reference antenna (a ½λ dipole, for instance).

In practice, however when one can move the antennas under test about easily, a much more simplified procedure is possible. The transmitter is connected to some available antenna. At a reasonable distance away, the standard or reference antenna is connected to a receiver. The transmitter power output and receiver gain are adjusted to produce some convenient reference level. The transmitter power output is noted. Then, the antenna under test is substituted for the reference antenna. The transmitter power output is readjusted to produce the same reference reading on the receiver. If the test antenna required only 1 watt of transmitter power to produce the same receiver reference level as when 10 watts were used with the reference antenna, the gain of the test antenna is simply 10 ÷ 1 or 10, which also happens to be 10 db. Remember that the numerical power ratio must be converted using a db power curve for db gain expression. Again, the antenna gains obtained by this method will all be referenced to the assumed unity gain (0 db) of the reference antenna.

Gain of Two Identical Test Antennas

Suppose that one had two identical antennas and did not know the gain of either nor had any reference antenna of known gain available. Surprisingly enough, the gain of the test antenna design can still be easily found. If the gain of both antennas in the test setup shown in Fig. 1 is the same, the original gain formula is re-arranged in the form:

$$G=4\pi\ D/\lambda \qquad P_{received}/P_{transmitted}$$

The received power and transmitted power can be measured with some specific antenna separation and the formula will yield the gain

of either antenna (as a numerical value, not in db). If the received power cannot be measured directly, the receiver can be used just to establish a reference level and the transmitter connected alternatively to one of the test antennas and then directly to the receiver to establish a power ratio that can be used in the formula.

The gain figure obtained from this procedure is mathematically related to a so-called isotropic antenna which radiates equally in all directions. A ½λ dipole antenna when used with this procedure should show a gain of slightly over 2 db—since it does concentrate its radiation broadside to the line of the antenna. Thus, if more complicated antennas are checked by this method the gain figure obtained must be reduced by 2 db if a comparison is desired with other antenna gain figures which use a ½λ dipole as a reference.

This procedure is frequently used to establish the gain of reference or standard antennas against which test antennas can be compared.

Gain of Three Different Test Antennas

Suppose that one had a group of three antennas none of which appear to have the same gain and no reference gain antenna is available to compare them against. By a variation of the previous procedure, the gain of all three antennas can still be established.

The antennas are arranged as shown in **Fig. 2**. The distances between them need not be equal but is assumed so to simplify this description. Using the basic transmission formula and when station 1 transmitts, the following formulas are obtained, each of which produces a simple number when the measured values are inserted.

$G_1 G_2 = (4\pi D/\lambda)^2 P_{rec.\ 2}/P_{trans.\ 1} = A$

$G_1 G_3 = (4\pi D/\lambda)^2 P_{rec.\ 3}/P_{trans.\ 1} = B$

Next station 2 transmits and the following relationship is determined:

$G_2 G_3 = (4\pi D/\lambda)^2 P_{rec.\ 3}/P_{trans.\ 2} = C$

Since three constants and three interrelated gains are concerned, the gain of each antenna can be found:

$G_1 = AB/C \quad G_2 = AC/B \quad G_3 = BC/A$

Again, the gains will be in numerical form and must be converted to db values. Also, the gains will be referenced to a theoretical isotropic antenna and must be reduced by 2 db for comparison to gains related to a ½λ dipole.

Precautions

The basic transmission formula used actually derives from optic equations, although it is the standard radio transmission formula. It

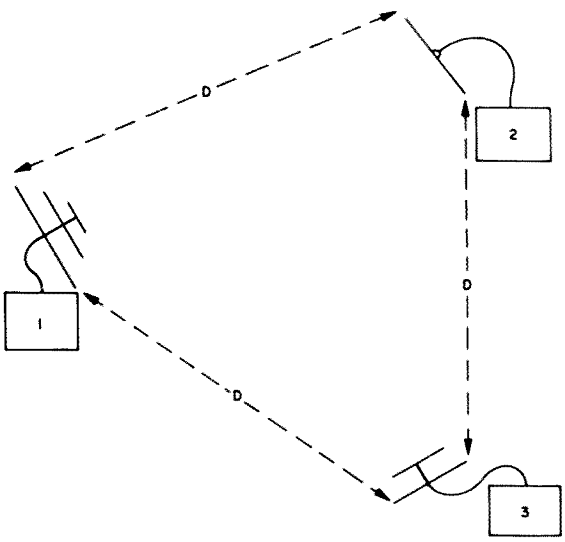

Fig. 2. As described in the text, the gain of three dissimilar antennas may each be found although the gain of none of the antennas is known. D, distance between antennas, need not be equal. The only requirement is that all the antennas have the same polarization.

does not take into account any other signals being present except the transmitted one in space. At high enough frequencies, this condition is reached with radio transmissions but at lower frequencies an antenna will receive noise signals as well as the desired signal. Therefore, allowance must be made, if possible, for the error caused by noise reception. If the received power levels are high compared to the received noise level, the noise effect may not be significant. At great distances and with low power levels meaningful results cannot be obtained.

Some other general precautions are:

1. Both antennas must be oriented for maximum signal before measurements are made. It can happen that maximum radiation does not coincide with the geometric center of an antenna.
2. The formula is based on line-of-sight transmission. Reflections, including those from inadequate antenna height, should be avoided.
3. The antennas must be separated sufficiently to produce a plane wave.
4. Correct impedance matches must exist throughout the transmitting and receiving terminals.
5. If the receiver is used as a power level indicating device, its gain must be reasonably stable or should be frequently checked. It must be operated in its linear range without overloading and with its avc off.

The use of a low power transmitter whose power output can be readily varied was as-

sumed. A signal generator of sufficient output power can also be used. If one uses a method such that connection of the transmitter to the receiver for reference level setting is not necessary, a transmitter of fixed power output of any level can be used.

Summary

When commercial laboratories make gain measurements using some of the methods described they take elaborate precautions to avoid effects that will alter true gain readings. However, even with simple equipment—even the regular station transmitter and receiver in many cases—meaningful results can be obtained.

Even if one does not measure the gain of any antennas, the material in this article should give a better insight to many amateurs as to how the gain figure for an antenna is determined. Particularly, it should clarify how antenna gain is always related to some *reference.* Thus, unless one knows the reference, one can easily read good-sounding but not really useful gain figures for some antennas.

Finally, it should be appreciated that gain is *only* a numeric and not the only meaningful characteristic of an antenna, although too to gain figures. Other factors such as the vertical and horizontal radiation pattern forms, front-to-back ratio, impedance, bandwidth, etc. are just as important and, indeed, in some applications more significant for best communication than gain. ...W2EEY/1

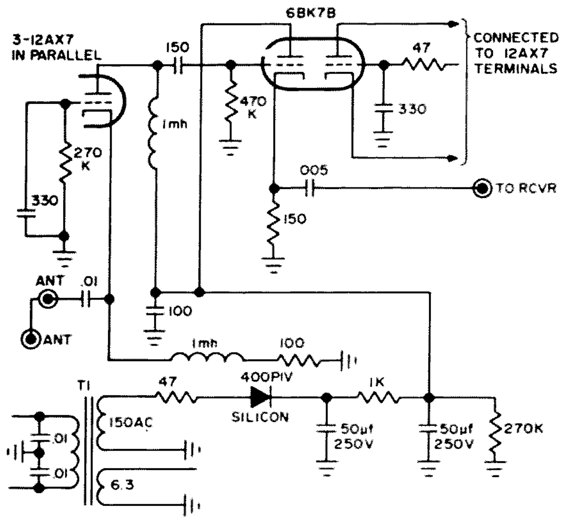

Fig. 1. A different TR Switch.

A Different TR Switch

The TR Switch described in May 1963 *73 Magazine* on pages 12 and 14 has undergone a metamorphosis or change for the better. While in some areas of the country the grounded grid configuration will function well, it behooves the amateur in a metropolitan area, especially where there are several marine, coastal, point to point commercial stations operating, to use a different circuit. The *rf* chokes, especially the one in the cathode of the grounded grid tubes, have a self resonant frequency and lo and behold, commercial stations can be heard in the background. Weakly, but still there. No amount of decoupling will eliminate them. Different values of chokes can be used, but then a sacrifice in gain on the amateur frequencies results.

The most satisfactory circuitry tried to date uses a cascode *rf* stage lightly coupled to the transmission line, and a cathode follower output to match the receiver input impedance. A tube rectifier is used as an *rf* rectifier to provide dc voltage bias on transmit times. There is no time constant—it is instantaneous, for CW, in order for fast break-in. When using SSB, the bias holds long enough between syllables so that the receiver stays blocked as long as you keep talking. When receiving, the rectifier has no effect, unless a kw station next door fires up. In that case, he will create enough bias in the TR switch to prevent overload of the set. It will lower the gain of your receiver, but without this effect, you would have another kind of trouble. You would probably go to the other end of the band or change bands. It will be apparent to the experienced constructor that this unit can be used as a tuneable preselector merely by substituting the 1 mh L_2 *rf* choke with suitable tuned circuitry. M. C. Smith, W6GMC

QRP - A New World to Conquer

Arthur Child, W6TYP
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Amateur radio has been getting more expensive and more complicated for those interested in building their own gear. It may come as a surprise to discover there are some hams who are finding ham radio simpler and more challenging. These unusual hams are the QRP operators, trying to use lower and lower powers to cover greater and greater ranges. For the QRP'ers a single transistor rates as a powerful transmitter, and communications may be maintained at power input levels so low they are hard to measure. Could you use your signal generator for a transmitter? If it is stable enough, yes! But it would be too complicated for a really convenient QRP rig.

QRP achievements are a real eye-opener. See Fig. 1. Powers much less than typical flashlight levels can achieve communication over hundreds or thousands of miles. Transmitter cost is small; there are no high voltages, and antenna systems typically range from Joysticks to carefully installed dipoles. The emphasis is on operating skill and on patience which gets you on the right frequency at the right time. At QRP levels you do not blast the opposition, you wait until he fades or quits. Or you learn to hear through him, and somewhere in there you become a real radio operator. In the QRP world the quality of the man is more important than the quality of the rig. The emphasis is on operating skill and patience. That is a refreshing change and this new perspective has proven reliably popular.

QSO	Time	Freq. MHz	Mw Input	Range Miles	Mi./ W. eq.
W8UUJ/6, Cal.	4 pm	7.015	33	273	8,200
WB2GFQ, N.J.	12 pm	7.142	50	2565	51,300
W7OE, Wash.	9 am	7.015	100	680	6,800
WA9DEU, Ill.	7 pm	7.015	500	1840	3,680
WA8JXQ, Ohio	8 pm	7.142	500	2110	4,220

All QSO's by calling CQ. None were arranged.

Fig. 1. Log excerpts. Every one of these contacts is above the basic 1,000 miles per watt achievement that gets you going in QRP.

A world-wide organization of QRP'ers has developed. Membership is about 3,000 radio amateurs, living in 50 countries. It may be these people are the very best radio operators in the world, since they routinely try to achieve effective communication at power levels comparable to the *unwanted* emissions from much amateur gear and far below that from some commercial broadcast transmitters. And, they succeed, setting records of thousands of miles on milliwatts of power. For instance, you can talk from San Francisco, California to South River, New Jersey, on 50 milliwatts input. It's an established record.

Art Child, W6TYP, writes he has been trying to make contact with QRP'ers in Japan and ZL land. Some entries from his log appear in Fig. 1. Previous results indicate he'll succeed since he is using his big rig for this project. It runs 500 milliwatts. Some other of Art's achievements are a 2½ mile QSO on 12 microwatts for 200,000 miles per watt and a 354 mile QSO on 354 microwatts for one million miles per watt.

QRP Recipe

Interested? Find a good receiver, or make up something from scratch. A good possibility appears in the 3-tube superhet described in the October 1968 issue of 73 Magazine. Perhaps you could do something with the regenerative detector circuit appearing in the same issue. And while you're working over the receiver problem (which will probably cost more than anything else) get a letter off to the QRP Club's corresponding secretary for additional information on activities and memberships. That goes to F. Behrman, K7LNS, 3425 S.E. King Road, Milwaukee, Oregon.

Next step is a good antenna. There is plenty of information around about antenna design and construction, and QRP work simply makes quality more emphatically necessary. The difference from a normal antenna will appear in quality, rather than expense, and this is largely a matter of care and workmanship. Installing and tuning a really effective antenna will require some test gear, and recent issues of 73 Magazine can offer material to help you out. A simple antenna bridge may do more for you than an swr meter, since you

may not have enough *rf* available to energize the meter. For many ideas see 73's special Antenna issue, May 1968.

As you get this set up you can think about your transmitter. Crystal control is preferred, so that once other QRP'ers know where your signal typically appears on their receiver dials, there will not be tuning questions with very weak signals. And you will appreciate the same reliability in their signals. On 40 meters the best frequencies are 7.015 or 7.142 MHz.

A typical circuit appears in Fig. 2. Few components could be pared out of this one. You will want to do some experimenting with this circuit, so start with a good high-frequency silicon or germanium transistor, use 1K ohms in the emitter circuit, and try 82K ohms in the base circuit. Place an mF as emitter by-pass, and a few picofarads in the base circuit to control feedback. C3 and L1 are tuned to the operating frequency and if L1 is a piece of Airdux, the antenna tap is easily moved up or down. Start with the tap close to ground, since antenna loading reduces *rf* available for feedback and at some point will cause poor keying. Listen to the signal on your receiver.

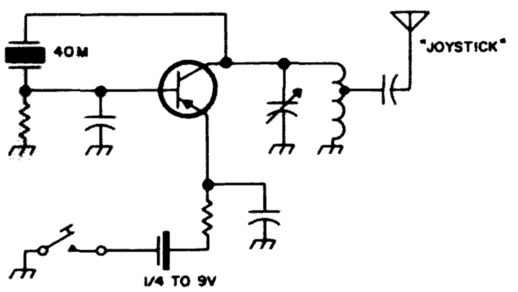

Fig. 2. This could be the simplest transmitter circuit ever published in 73 Magazine. Inexpensive, too. The "Joystick" antenna is in the same room, eliminating coupler, transmission line, etc., and tapping up the coil increases loading. When you can get out with this, you are learning to be a really good operator.

International's printed-circuit crystal oscillator can also do a nice job as a transmitter. The printed-circuit construction is very neat, and the kit sets you back $2.35 postpaid. See October issue of 73 again, page 5. The crystal runs another $3.75, specify the frequency. And another dollar should get the *rf* well started toward the antenna.

Finishing up the rig, you put a TR switch in the antenna system somewhere and you are in business. The transmitter frequency is located during tests by tuning the receiver to pick up the transmitter—you don't do this with a kilowatt! with key down. The receiver would probably not be harmed if you fed the transmitter's entire output into its front end and in some station setups you might have a little difficulty finding the transmitter signal, but a clip lead will help you out. Better be careful on principle, though, if your receiver has a solid-state front end.

Finally, start calling. It will take patience. After all, the air is full of high-power operators, some of whom tend to ignore signals under S9 or so. Yours will be one of these.

Soon you will learn to operate odd hours. Perhaps the honorable art of ragchewing will appeal to you, again. And you will wake up sometimes in the middle of the night thinking about a QSO, and why not? You are likely to become an early bird, early to bed and early to rise. This is said to offer valuable benefits unrelated to ham radio, and it also gives you a fantastically quiet band to operate in. The signals seem to sound different at this time of day, just before the sun is coming up. It is an experience you shouldn't miss.

QRP Performance and Records

Communications at QRP show a very strong dependence upon propagation conditions. On 40 meters, for instance, the best results are achieved late at night, as you might expect. But at QRP you cannot ignore the facts and vagaries of propagation conditions. They just jump right out at you, and you will soon become interested in the fluctuating conditions of the ham bands.

Once contact is made at, say, high power of 500 milliwatts then you can start ragchewing. QRP contacts, unlike DX contacts, may go on for extended periods as you and your contact crank down the power again and again, trying to achieve effective communication with the smallest transmitter power input.

When your log shows you can get a 1,000 miles per watt certificate from the QRP Club you are starting to achieve results. But the records are very much better than that, and recent work includes contacts on 40 meters ranging from 325 miles at noon to 2565 miles at 11:00 p.m., local time. On 50 milliwatts. That's better than 50,000 miles per watt. One million miles per watt is possible and has been achieved. Such records are unusual and definitely worth working for. Aside from the fact they offer an interesting challenge of the very best kind, you are sure to meet unusual and interesting people along the way. Don't miss the opportunity to enjoy QRP operation.

...W6TYP

The Galaxy GT-550 Transceiver

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A decade or so ago transceivers came into being primarily for mobile application. Almost as an afterthought manufacturers made available AC power supplies for alternate fixed station use. Subsequent trends have caused transceivers to evolve in complexity (and size) to become complete, single package stations; some with an array of controls calculated to send a computer programmer into frenzied rapture. But have you ever tried to fit one of these integrated jobs under the dash of a Mustang? Or juggle a bank of knobs never designed for compatible freeway operation?

When Galaxy Electronics introduced their model III and V transceivers, it was obvious they had the mobile ham in mind as evidenced by functionally located controls, a tuning dial on the left side for optimum driver manipulation, and dimensions ideally suited to underdash installation. And a lot of fellows discovered that, with an outstanding receiver circuit and 300 watts PEP input, the Galaxys did an excellent job in the shack. Their feather weight and easy mobile mount made dual usage a snap.

The model V Mk 2, besides increasing input to 400 watts PEP, also added features for the CW operator such as sidetone, and plug-in options for semi-break in and a 300 Hz receiver filter. The V Mk 3 incorporated final tubes capable of 500 watts PEP.

Galaxy also developed a line of accessories for full fixed station flexibility with their transceivers, while retaining the inherent simplicity, desirable for mobiling, in the basic transceiver. This also permitted the buyer the choice of paying only for those features required for his particular mode of operation.

Having used a Galaxy V Mk 2, shared mobile and fixed, for a couple of years, I could testify to its performance, stability and rugged construction on the highway, while 108 countries and a lot of good CW work with an apartment trap vertical left little to be desired at home. With this experience, it was difficult to conceive that much room was left for improvement...that was, until at the recent SAROC convention, I witnessed the unveiling of the Galaxy GT-550.

Gone was the former, somewhat austere, front panel – to be replaced with contemporary styling guaranteed to gain living-room acceptance from the most discriminating XYL (mine). While keeping the same well-arranged controls, now with skirted knobs, a new single-scale, 500 kHz dial eliminates the second scale that formerly reversed frequency direction for tuning 20 meters. Now CW and phone segments have the same dial relationship on all bands – a pleasure for CW DX bandhoppers like me. The familiar two-speed tuning knob is supplanted by a massive, 2½" diameter, single speed knob with plastic insert finger spinner. The spinner permits traversing the entire 500 kHz range quicker, and more easily than the wrist switching action required with the old two speed control. The 72:1 ratio tuning is velvet smooth and the kingsize knob gives finger-tip precision with no discernable backlash, even when using my narrow bandwidth CW filter.

Black on white tuning and S-meter dials, indirectly lighted behind rectangular windows, make for easy reading and enhance the new styling.

A study of the schematic proved that the GT-550 is based upon the tried and true cir-

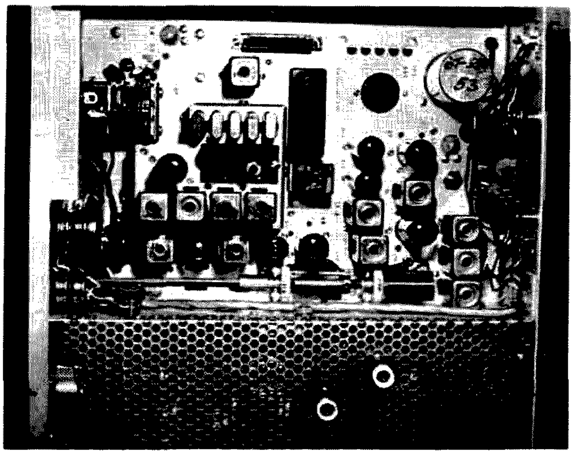
cuitry developed through the earlier Galaxy series, with numerous significant improvements. The new parallel 6LB6 finals, together with a redesigned driver stage, provide improved linearity and ALC action for 550 watts PEP input. On CW the final operates at 360 watts input with reduced screen voltage for maximum tube life. As in previous Galaxys, the TUNE mode may also be used for CW operation, with input power continuously variable by the MIC/DRIVE control, from a fraction of 1 watt up to 250 watts.

Many circuit changes noted indicate continuing effort for peak performance in both receive and transmit modes. The already sensitive receiver circuit has been made even more so on the GT-550, as is particularly apparent on the ten meter band. This is where so many receivers show a drop-off in performance, but the GT-550 S+N/N ratio is extremely good. An added crystal for vfo hetrodyning has eliminated the need for that separate scale on 20 meters. Improved high and low voltage regulation includes provision for accurately adjusting the regulated 12 vdc used for the vfo, and also brought out to a rear panel jack for accessory operation. ALC control voltage is also brought to a rear jack for use with a linear amplifier, and is handy for plugging in a vtvm to observe where alc action begins relative to plate current peaks when setting the MIC gain control. Another added jack for the external vfo accessory, obviates running coax through a rear panel hole to a chassis jack, as in earlier Galaxy models.

Those operators who periodically check alignment to maintain top performance, will be glad to know that mechanical design of the GT-550 has made all alignment procedures possible from the chassis topside. No need to remove the bottom plate and balance the unit precariously on one side. In fact, the GT-550 can be completely aligned in its normal operating position by merely removing the top cover. Even RC 'swamp' circuits required for accurate adjustment of double tuned transformers, are built in. Just shorting a chassis test point to ground with a screwdriver swamps one winding while the other is being peaked. A vtvm chassis mounted test jack aids in alignment.

The bank of five band-hetrodyning crystals are mounted atop the chassis for accessibility—a convenience for operators wanting to substitute crystals for extended 10 meter or MARS frequencies.

The single piece top cover can be lifted



Interior view of the GT-550 Transceiver.

off, or slid back on the unit, for easy access by removing four screws. New design permits removing the final compartment shield without having to take off the bottom plate. The same basic dimensional configuration maintains the GT-550's adaptability to mobile or fixed installations, and the appearance is equally pleasing in both.

Like its predecessors, the GT-550 comes with an individual frequency drift calibration chart, as measured at the factory prior to shipment. Mine indicated a maximum warm-up drift of 140 Hz in the first 20 minutes, after which stability remained within a range of 10 Hz for the 40 minute balance of the test period. This degree of stability has been borne out in actual operation.

Checking the actual power output with a Waters Dummy Load Wattmeter Model 334, the following maximum readings were obtained when loaded according to instructions:

TUNE mode: 160 watts, CW mode: 280 watts.

SSB mode (1 kHz sinewave to MIC input): 400 watts.

The GT-550 can be powered either by the AC-400, a new heavy duty supply with switch selection for 115-230 vac, 50-60 Hz input, and solid state rectification; or the G1000DC supply for 12 vdc mobile installations.

All in all, the GT-550 offers a lot of transceiver at moderate price. Add plug-in options for the CW man, and a line of accessories including plug-in transistorized 25 kHz calibrator (for those new band limits); complimentary styled external VFO, 2 kw PEP Linear Amp., Hybrid Phone Patch with tape recorder facilities, speaker console that accommodates the AC-400 supply, and an RF Console that switch selects up to five antennas plus dummy load—with built-in forward/re-

flected wattmeter...and you have building blocks for a home station tailored to your needs, around a state-of-the-art transceiver ideally suited for mobiling.

Technical Specifications

Frequency Coverage—3.5-4.0; 7.0-7.5; 14.0-14.5; 21.0-21.5; 28.0-28.5; and 28.5-29.0 MHz with crystals supplied. Additional ten meter and MARS frequencies with accessory crystals.

Dial Calibration—5 kHz increments. 500 kHz range, with single linear scale—over 12 inches of bandspread. 72:1 ratio vernier tuning.

Operation Modes—Selectable USB-LSB, suppressed carrier. PTT or VOX (with optional accessory). Shifted carrier CW, manual or semi-break in (with vox accessory). Built in sidetone.

Transmitter—SSB input: 550 watts PEP. CW input: 360 watts. Carrier suppression -45 db. Unwanted sideband suppression, better than -55 db. Antenna load impedance, adjustable 40-100 ohms. Hi-Z microphone input for -50/60 db level.

Receiver—Sensitivity better than ½ μV for 10 db S+N/N ratio. Double action, fast attack delayed release, audio derived agc. Nominal 1 watt audio output to 8 ohm external speaker.

General—Crystal lattice filter on transmit and receive provides 2.1 kHz selectivity with 1.8:1 shape factor. Audio response 300-2, 400 Hz at -6 db points on receive and transmit. Dimensions approximately 7½" H x 11¼" W x 13-3/4" D. Weight approximately 13 lbs.

...W6AJZ

DX QUIZ . . . Answers

Here are the answers to the quiz on page 38 Score five points for each correct answer. 75% is very good, 90% is unbelievable.

Congo		Republic of	
Republic	TN	Guinea	7G1
Republic of the		Uganda	5X5
Congo	9Q5	Rwanda	9X5
Mali	TZ	Niger	5U7
Central African		Tanzania	5H3
Republic	TL	Gabon	TR
Senegal	6W8	Spanish	
Cabindi	CR6	Guinea	EAØ
Fernando		Mauritania	5T
Poo	EAØ	Lesotho	7P8
Zanzibar	VQ1	Mozambique	ZS9
Chad	TT	Botswana	CR7

Novice Antenna

One of the problems the Novice has is the antenna. Many times it is a problem because of lack of knowledge, space or funds. Here is an 80 meter vertical which solves all the problems.

Most of the parts can be scrounged. You will need 17 feet 4 inches of ½" thin wall electrical conduit; a 5-foot piece of 2x2 inch lumber; a 4-foot length of tubing to use as a supporting mast; a coil, and some hardware.

Bolt the conduit to the 2x2, overlapping about 2 feet. The top of the loading coil (in this case Illumitronics #2010—#16 wire, 2½" diameter, 10 turns per inch) is bolted to the conduit and the bottom of the coil is bolted to the wood. The supporting mast is then bolted to the other end of the 2x2 and sunk into the ground. 50 ohm coax is used to feed this antenna. The shield of the coax is connected to the mast, and the center conductor is temporarily fitted with an alligator clip for ease in tapping the coil.

Using an swr indicator, tap the coil at the point where the lowest swr is found. In my case, this was about 23 turns. The swr was still about 2:1. To bring it down, cut two radials ¼ wavelength long and connect to the point where the coax shield is connected to the mast. The radials can be buried. Pruning the coax length will also help bring down the swr at the transmitter.

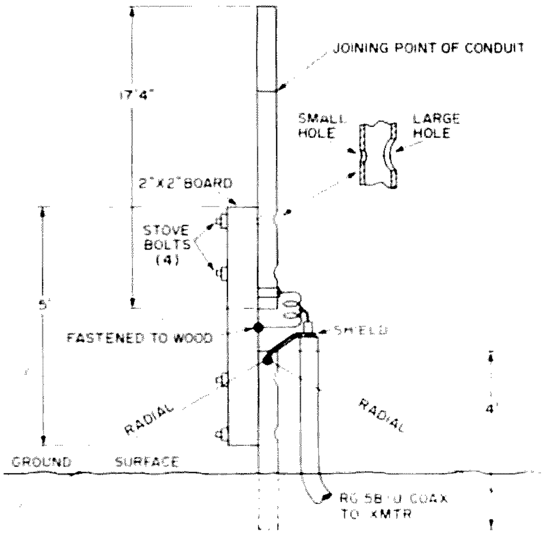


Fig. 1. Variable is mounted on the 1¼" TV mast.

Now that you are thoroughly confused, look at **Fig. 1** and you will see the arrangement.

Wayne Jinske, WA9SSH

The Super SS

Clifford Klinert
520 Division Street
National City, Calif. 92050

A Real Life True Adventure Story

It is Saturday afternoon. I return home from work slightly tired, but refreshed in the thought of the weekend ahead. It doesn't happen often, and I really look forward to a little relaxation with my favorite hobby. I feel deep pride to be a member of the ARRL, the organization that arranges these contests. There is nothing I enjoy more than operating my station with the best of my speed and skill competing with others doing the same.

To the shack. Check it out. Twenty meter beam. Forty meter dipole. I turn on the transmitter. Oscillator. Drive. Plate tuning. 300 mils. Good. I turn on the receiver. Let's see who I clobbered. Nobody heard me. Good. Coffee. Pencils. Log. Paper. Clock. Check. Let's go.

I reach for the receiver dial, the hard black knob feels smooth in my fingers. Smoothly as velvet the pointer moves up the scale. The QRN ebbs and flows like waves on the beach, now softly sliding across the sand. Up through the noise pops a signal. I gently nudge the antenna trimmer until the rhythmic beat of a steady fist rings clear as a bell.

CQ SS. It's a VE. Must turn the rotor. Reach for the control. Click-click-click-uummmh. The lights dim. Pull the leads apart. No good. Pull the line cord.

Slightly despondent, I pace the few steps to the door and begin the painful ascent up the tower along the wall. With a mighty effort I pull myself to the roof. The sun is down now and a light mist hangs over the city softly filtering the strange glow from the mercury vapor lights on the street. Above arches the twenty meter beam like a parasol with its elements reaching into the darkness. Thin wisps of smoke curl from the bottom of the rotor, almost masked by the veil of the fog.

Up the tower. Good thing it's strong. Welded it myself. Know it's right. At the top. I wrap my legs around the tower and grip the boom. Pull. Harder. Gears frozen. Pull harder. Crack! Small piece of tower hits the roof. Hold tight to boom. Boom bending. Crack again. Here comes the rotator. Metal fatigue. Gotta work on that. Falling. Here comes a guy wire. Rotator catches. Hanging on. Snap! Cheap guy wire. Buy it new next time. Here comes top of tower

Almost gently the top of the tower rotates downward, bending at the center and picking up speed. Now, nearing the roof, I hold tightly and watch its sickening descent. The top of the tower shears off the corner of the roof like a knife slicing butter. Now I carefully make my way down the remains of the tower, nothing but a grotesque tangle of twisted metal.

Wow! Splinters and roofing. Down to the ground. Forty meter dipole still OK. Shack OK inside. Only slight hole in roof. Bandswitch. I call CQ SS. Plate meter pins. Lights dim. Final's shorted. Power switch. Reach inside. Pull shielding off finals. It hit me. Wall falling away. Floor hits me. Everything black. Feel. Hard floor. Still alive. Reach for drawer. Flashlight.

The small sharp beam of the flashlight questioningly probes the darkness, tracing a cloud of thick grey smoke. I carefully sort through the tangle of wires and unplug the transmitter. Painfully, I limp outside and recycle the circuit breaker. I force myself back and view the damage. The power switch is welded on by the high current. The silicon diodes, now completely ruined, are blisteringly hot. Now the receiver once again warms up and returns to life.

QRN. On my frequency. Now calling me. A ZL. Pretty good signal. I grasp the receiver with both hands. Wires breaking off. Over my head. Heavy. Push hard. Across the room. Into the wall. Plaster and wood splinters. Wow! Tear up ARRL certificate. On the floor.

Once again I make the trip across the room. I move more slowly now with the seething forces inside me subsiding. I gently pull the light switch and close the door. I stroll toward the house carefully stepping over an object in the path. Some smoke still diffuses through the hole in the wall into the still purity of the night. The sky is now perfectly clear with the stars flashing like gold sequins on black velvet.

Quiet. To the house. Open the door. Wife. Still awake waiting. Arms around my neck. Soft. She speaks.

"Have a good contest?"

Yes. ...WB6BIH

A Novel Approach to Feeding and Tuning the Three-Band Boomless Quad

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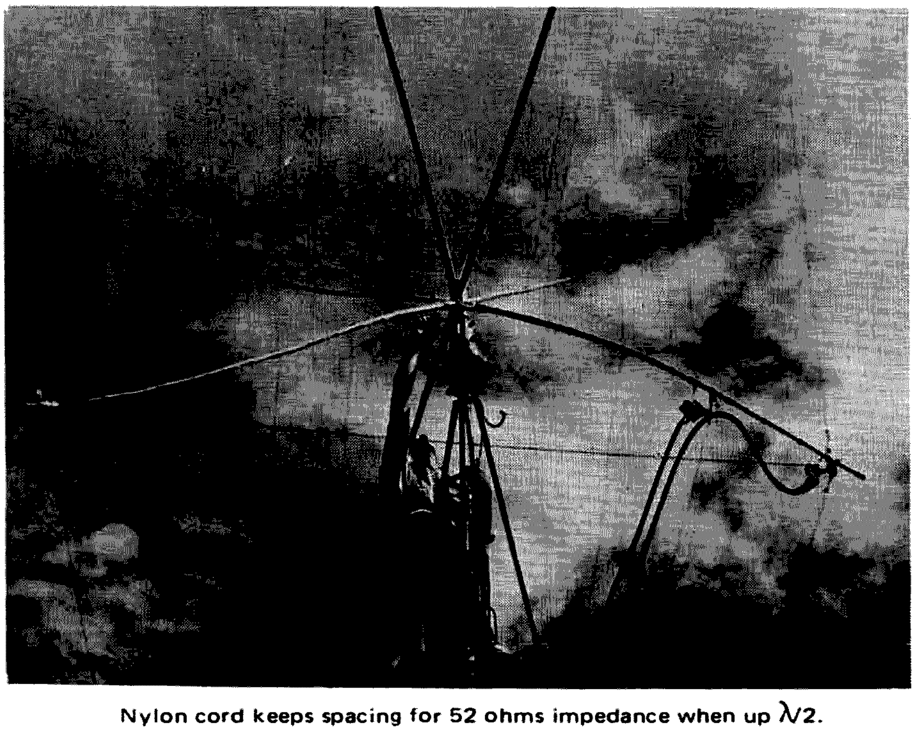
Member of the Bar,
U.S. Supreme Court

Although I learned two codes at age 13, one of 13 children on a farm in Wisconsin, and received my discharge from the Signal Corps in Washington, D. C., in November 1912, I did not obtain my General license until March 1948 and my Class A in March 1950.

One day I worked W3JXH in nearby Maryland and was invited to drive the few miles to see a quad antenna, my first. It turned out to be a 10-15 two-element all-metal job and only a few feet above ground, surrounded by buildings and overhanging trees, and enclosed inside a high steel fence. The owner claimed fine dx contacts.

I then went about building a 15-meter all-metal quad with both elements grounded on the upper boom. Although this quad had excellent F/B ratio, the band remained dead for several days, so the 15-meter job was taken down and a 20-meter quad of similar type built to take its place. It was initially fed at only four feet three inches from the ground. The first contact was with K3UIG, a "Government Employee" nine miles across town. The QSL which arrived two days later bore the name Barry Goldwater, with a beautiful color photo of the Nation's Capitol building. Other contacts were mostly beyond the Mississippi River and Central America and, when the band was either just opening or closing, generally quad-antenna stations answered. Diamond-shape quads are said to have a lower angle of radiation. Before leaving Washington, D. C., I gave this quad to W3YAE.

After arriving in Florida I decided to experiment with quads of the more conventional square, all wire type. Twelve different quads were built and torn down – boom, short boom and boomless. No. 13, the



Nylon cord keeps spacing for 52 ohms impedance when up λ/2.

present one, a boomless quad, was designed by W4TZ, across town, who had two composite aluminum spiders electrically welded, one of which was assembled and erected on the tower by me (age 76) without any help and without use of a safety belt. The decision not to use the safety belt loaned by W4TZ may sound a bit queer. Some 65 or 70 years ago a group at a Wisconsin family reunion witnessed a dog attempting to scale a picket gate, as he had done many times before. He caught the ring of his collar on a picket and hung there helplessly. Hanging by a safety belt, should my foot slip, might temporarily knock the breath out of an old man! However, I strongly recommend the use of safety belt, especially to you younger fellows with still many years ahead of you.

The accompanying photo shows the composite spider to have an aluminum plate at the center with eight short aluminum radials electrically welded thereto at an angle so that the spacing between the 20-meter driven element and its reflector is 6 feet 10 inches, with a corresponding lesser spacing for the 15- and 10-meter elements. This spacing, with the reflector properly tuned at a sufficient height above ground, resulted in a unity SWR when fed with RG/8-U or RG/58-U. The Quad handbook says that if the quad is below a certain height the impedance drops to one-half.

Square quads are normally fed at the center of the lower horizontal wire of the driven element. Since dipoles fed at the center are said to be a reasonably good match for 72-ohm feeders, and an inverted "V" having a 90-degree angle is said to be a good match for 52-ohm RG/8-U, I chose to feed my square, boomless quad at one lower corner for the following additional reasons: 1) the feeder may be fastened to the radial, thereby lessening sway in wind; 2) no need to pull the center of the driven element upward, out of shape and out of true with the reflector; and 3) it seemed to be more convenient to attach the SWR bridge at this point during tuning procedure. Believe it or not, it worked!

Fig. 1 shows construction of tuning coil at the corresponding (but opposite) corner of the reflector. Note the absence of long tuning "stubs" in the photo, which not only distort the plane at the current node, but also tend to affect the adjacent bands. The tuning coil was formed by winding antenna wire on a 7/8-inch dowel and, when released, forms approximately a one-inch diameter

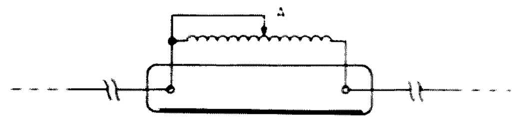


Fig. 1. Tuning Coil. When SWR bridge approaches unit, the clip A is removed and the short lead soldered to the turn. A change in capacity and configuration of coil might affect SWR if the shorted portion of coil were to be removed, more so, on 10 meters than on 20 and 15. Less turns are needed on 15 and 10 meters.

coil. This coil was then spread slightly and fastened to the ends of a somewhat shorter, thin insulator so that the outer edges of the turns are spread sufficiently to permit clipping a short piece of wire to a single turn without shorting an adjacent turn. Although less turns are needed for 20 meters, I started with a 26-turn coil because of the length of the insulator on hand and made the initial tap at the center turn, thereby shorting out one half of the coil.

Tuning was accomplished with a low power SWR bridge at the feed point where it could be clearly read at that short distance, and at a time when the band appeared to be dead or "out" so as to reduce chances of interference. Remember, I had no assistance and had to ascend and descend the ladder and tower (more than once!) to accomplish the tuning. A short piece of vinyl from the coax had previously been slipped over the clip to prevent *rf* burn when changing taps on coil. The coil being at the radial, it was easy to steady it during the tuning process by grasping the radial with the other hand. It was only necessary to go a turn or two either side of the original tap to arrive at the desired swr. The clip was then removed and the wire soldered in place, a 50-foot extension cord having furnished the required power for soldering gun. After removing the bridge and replacing it near the rig, it was only necessary to make a two-foot change in the feeder length to secure a like SWR reading of 1 to 1 at that location.

I used a 3-cent, home-made balun, following the general instructions for a 1 to 1 balun in August 1964 QST. The core is about 2 inches of ferrite obtained from a discarded BC loopstick, and wound with the necessary turns of No. 16 copper enamelled wire. It is not sealed, but merely taped. Weather? Reports from contacts do not materially differ, whether during dry weather or rain.

W4TZ uses a common feeder for the three bands, and a quarter-wave sleeve balun

at each of the respective feed points, and the other ends of the quarter wave fastened to the common feeder. His watt-meter shows remarkably satisfactory swr.

Incidentally, either bamboo poles or fiber-glass radials may be slipped into the short, slotted aluminum arms of the spider and a non-skid hose clamp secures the radial.

The width of the tower shown in the photo was such that only one foot could be placed at a time on any cross-member. The other leg and one arm were draped around the tower during the erection of the quad, and the free hand was used to put the thing in place. The necessary tools had previously been placed in accessible pockets. The tower was not of the tilt type.

If an old man can assemble, erect and tune this boomless three-band quad without assistance, you younger fellers should be able to obtain similar satisfactory results.

Recently a station reported an S-8 signal off the back of the quad, but 20 over S-9 from the front. Not bad!

It is understood that fiber-glass radials now come in four-foot sections whose ends slip readily into each other, and are mailable by parcel post. At this point it may be of interest that I and my supervisor inaugurated the Parcel Post System in 1913 after trials at Chicago, St. Louis and New York to obtain size, weight and cost data.

If and when I can secure an aluminum welder (electric), I may be able to furnish this composite spider (and radials). That, however, was not the intended goal when this No. 13 boomless quad was designed.

Acknowledgement is hereby made to W4TZ for his assistance in designing the angle of the spider and having the first two prototypes made; also to C. D. Bently for photograph.

. . . WA4VWY

Mosley 80M Dipole Kit

The DIV-80 Dipole antenna is a complete package designed as a regular or inverted vee dipole for 80–10M. It is rated at 2 KW PEP or 1 KW on AM or CW. The Kit includes 140' of Copperweld wire, a Mosley Dipole Connector (DPC-1) and two ceramic end insulators. The Kit includes simple instructions for pruning the antenna to the co-rect length for the part of the band in which operation is desired. It might be worth a mention that many stations using inverted vee antennas on 80 meters are working DX with ease.

To Patch or Not To Patch

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For 20 years, hams have argued about phone patches. After a generation of discussion, the matter is about to be settled. The phone patch may become another "standard" appliance in the ham shack. But not without some trials and tribulations.

The idea of the phone patch is almost as old as the radio and the telephone. Military services have used "radio-wire integration," and the phone companies have long distance radio links. Telephones in private automobiles are obviously phone patches. Amateur equipment has included phone patches for years, too. A number of respected companies make them, and articles have appeared from time to time in CQ and 73 magazines. Why, then, is there so much confusion? The problems and arguments start with the "tariffs" filed by the telephone companies. For most practical purposes, a tariff can be considered as a law. Almost every telephone book prints a tariff which bothers the amateur with a phone patch—"No equipment, apparatus, circuit or device not furnished by the telephone company shall be attached to or connected with the facilities furnished by the telephone company...." The arguments caused by this tariff are shown by the attitudes of the amateur radio magazines and the ARRL. CQ magazine has continued to print phone patch articles. 73 magazine has been rejecting articles until a decision is made by FCC. And the ARRL has maintained the opinion that all phone patches are illegal. There is no mention of phone patches in "The Radio Amateur's Handbook," and the only mention of telephones warns the amateur to contact the telephone company if telephone interference occurs.

The official attitude of the telephone companies has been that phone patches were not legal. As a practical matter, though, "Mother Bell" has realized that amateur use of phone patches actually increases telephone traffic. Of course, there were objections if the amateur tried to connect his own extension phone in the shack and to install the wiring himself (thus avoiding extension phone charges). Poorly designed or operated patches have sometimes (though seldom) brought a knock on the door. But as a practical matter, the ham who asks the phone company to install an extension phone in the ham shack has usually found that the phone installer is quite willing to assist in hooking up the phone patch. At least, that way, it is done correctly. The fact is that hams have rarely (if ever) been prosecuted for operating a good phone patch.

The possibility has always existed, though, that the amateur might be doing something illegal. This possibility has resulted in a great reluctance to use phone patches. Some recent decisions of the FCC may change the tariffs, and could result in expanded use of the phone patch.

The FCC can, if it wishes, review telephone company tariffs and set aside those tariffs it does not approve. In 1956, the FCC's "Hush-A-Phone" decision caused a clarification of tariffs to allow use of devices which are not electrically connected to the phone. The legal wording of the decision caused many lawyers to feel that amateur phone patches would also be considered legal, although they are usually connected to the phone lines. After 12 years, in June, 1968, the FCC has clarified its position in a decision on the "Carterfone" case. The most significant portions of the FCC opinion are printed below.

> We hold that the tariff is unreasonable in that it prohibits the use of inter-connecting devices which do not adversely affect the telephone system....Our conclusion here is that a customer desiring to use an inter-connecting device to improve the utility to him of both the telephone system and a private radio system should be able to do so so long as the inter-connection does not adversely affect the telephone company's operations or the telephone system's utility for others. A Tariff which prevents this is unreasonable....We are not holding that the telephone companies may not prevent the use of devices which actually cause harm or that they may not set up reasonable standards to be met by inter-connection devices. These remedies are appropriate. We believe they are also adequate to fully protect the system.

The opinion set aside the tariffs preventing connections to the telephone system, and

declared that they "are and have since their inception been unreasonable, unlawful, and unreasonably discriminatory..." The "Carterfone" decision, then, declares that phone patches are (and have always been) legal, if they do not harm the telephone equipment.

This decision, and tariffs effective January 1, 1969, (more on this later) have caused the ARRL to change its mind and allow phone patches as "legal" traffic. But, as might be expected, the telephone company does not appreciate the FCC decision. "Mother Bell" will lose a lot of money if customers go elsewhere for Teletype interface, facsimile, and data transmission equipment. The telephone company has appealed the decision—or at least a part of it—in a New York appeals court. This action is mostly intended to prevent suits by Carter and others, and doesn't appear to be intended to overturn the entire FCC decision.

It seems that AT&T intends to get the most mileage from the part of the FCC decision which says "We are not holding that the telephone companies may not prevent the use of devices which actually cause harm or...set up reasonable standards to be met..." Under this part of the decision, AT&T *could* file a tariff requiring inspection and approval of any connected device (including phone patches) by the local telephone company. This procedure has been in effect for some time to allow customer use of the customer's own telephone instrument as an extension. Inspection of the extra or "decorator" phones often costs $10 or more. Checking a phone patch would probably cost so much, or take so much paperwork, that the average ham wouldn't bother.

The move which prompted ARRL's acceptance of phone patches was the AT&T tariff (FCC) Number 263, which was effective January 1, 1969. This tariff has, in turn, been "reproduced" by the telephone operating companies and filed with state regulating agencies. The provisions quoted below are from Mountain States Telephone and Telegraph Co. General Exchange Tariff for New Mexico, Section 17, Part 12, effective January 6, 1969. The FCC tariff, and other local tariffs, are almost identical.

> Connection with customer-provided Equipment and Facilities....Certain customer-provided voice transmitting and/or receiving terminal equipment may be connected to the Exchange and Long Distance Message Telecommunications networks at the regulations, rates, and charges specified herein. ...May be connected through a Telephone Company network control signaling unit at the following rates and charges: Connecting arrangement, for connection of customer-provided voice transmitting and/or receiving equipment (including switchhook control key), each (QKT) $ .50 monthly. Maintenance service call resulting from customer-provided equipment, each $10.

This "QKT" connecting arrangement is rather simple. The "network control signaling unit" is a slightly-modified telephone instrument. A special switchhook key is provided. One of the buttons in the telephone cradle may be lifted and locked into place, which will cut out the telephone transmitter element and switch in a special set of coils hooked to the "QKT" jack.

The Electronic Industries Association has called the "network control signaling unit" provision of the tariff "common carrier featherbedding." The provision means that the customer cannot provide his own means of dialing, impedance matching, or answering of calls. While this provision will not bother most hams, some of us like to provide our own dialing arrangements. In addition, no matter how good your patch is technically, *even if it is better than telephone company equipment* (and many are), the company won't trust it.

The 50 cent monthly charge seems reasonable, although it does add up to $6 a year. Of course, a one-time installation charge is added (about $6.50), as well as the monthly cost for the extension phone if the one in the shack isn't the only one in the house.

The "maintenance service call" provision of the tariff means that any trouble caused by your phone patch will cost you $10. If you complain about your telephone service, and the cause is really your patch, it's your $10. If it's the fault of the telephone company, there is no charge. And, of course, if your patch causes problems which bring an unasked-for knock at the door, this will also cost you.

The "QKT" jack provides access to a 900-ohm matching coil within the telephone. For phone-patch purposes, you can treat this just like a telephone line, except that you cannot use it for dialing, and you cannot "answer" or "hang up" using this line. The 900-ohm figure probably comes as a surprise to you, as it did to me. For years, we have been thinking that line impedance was 600 ohms, and carefully designing our patches to work into that figure. The old, open-wire telephone lines *were* 600 ohms. It came as a great shock to me to learn that almost every sub-

scriber line in the United States now has a nominal 900-ohm impedance. This fact will probably be a surprise to most phone patch manufacturers, also. However, the 600-ohm equipment has worked well in the past.

There are other restrictions on what you can feed to the jack supplied by the telephone company.

> ...Power of the signal at the central office (must) not exceed 12 db below 1 milliwatt averaged over any 3 second interval....The power of the signal which may be applied by the customer-provided equipment to the Telephone Company interface located on the customer's premises will be specified for each type of connecting arrangement but in no case shall it exceed one milliwatt.

In other words, you are not allowed to over-drive the telephone company lines. This is a reasonable provision, and should be the basis for providing a meter on your phone patch, although most patches don't have meters. It is not too likely that your patch will provide more than a legal signal. If it does, the "network control signaling unit" has *some* built-in compensation. Of course, the telephone company *could* specify an unreasonably low input level. Line loss can be as high as 10 db. Be suspicious in this area, but don't leave yourself open to that $10 charge.

> The power in the band 3995 to 4005 Hertz shall be at least 18 db below the limit (that is, 18 db below the 12 db below 1 milliwatt at the central office)....The power in the band 4,000 Hertz to 10,000 Hertz shall not exceed 16 db below 1 milliwatt....10,000 Hertz to 25,000 Hertz–24 db below... 25,000 Hertz to 40,000 Hertz–36 db below ...above 40,000 Hertz–50 db below...

These figures give the "low-pass" filter requirements which your phone patch must meet. They should not cause any difficulty.

> To prevent interruption...(the) signal (will) at no time have energy solely in the 2450 to 2750 Hertz band. If signal power is in (the) band, it must not exceed the power present at the same time in the 800 to 2450 Hertz band.

This rather simple restriction is the reason for the occasional unexplained disconnection of an apparently-good phone-patch circuit. The telephone companies use special signals in the 2450-2750 band which are the equivalent of a "hang up" command, and the call is cut off. An occasional hetrodyne at the wrong frequency can cause this problem, but there is not much you can do about it.

Other Methods

There is one other way to accomplish a phone patch, and it can be done at a saving. Section 20 of the tariff provides restrictions on "Inductive or Acoustic Coupline," which can be used *without charge.* I suspect that there will be quite a bit of amateur development effort toward developing inductive or acoustic phone patches. The restrictions are as follows: "...Network control signaling shall be performed by equipment furnished, installed, and maintained by the Telephone Company.

In other words, you have to have a telephone. No fair just inductively coupling the patch to the telephone company lines. "...Connection is made externally to a Telephone Company network control signaling unit."

You can't put part of the patch inside the telephone. The inductive coupler or acoustic arrangement must be outside the phone.

> ...Equipment must comply with the following minimum network protection criteria: ...The power of the signal which is applied by the customer-provided equipment to the network control signaling unit located on the customer's premises be limited so that the signal power at the output of the network control signaling unit (i.e. at the input to the telephone company line) does not exceed 9 db below 1 milliwatt when averaged over any three second interval....(and)....(frequency/power limits).

Notice that the signal power restriction is 9 db below 1 mw *at the line input,* rather than at the central office. If your line happens to be among the worst, your signal could be 19 db down at the central office, rather than the 12 db allowed for an electrically (QKT) connected system. This is rather restrictive, and again industry has objected. The frequency/power limits are the same as listed before, except that they are referred to the minus 9 db figure.

Now What?

With phone patches now legal, the amateur "fraternity" should take some positive action. Each of us with a phone patch must make sure that the patch is operated properly and that it is not harming the telephone equipment.

Since a tariff now exists for customer-provided equipment, the telephone companies can no longer turn a blind eye on phone patches. The cost is really very reasonable, and the peace of mind is worth it. Call the local company and get "legal" yourself.

Since the ARRL now recognizes phone patches, we should urge the ARRL and any other interested amateur groups to present the amateur views on this subject to the FCC

and the state regulating agencies. I feel that a well-designed phone patch should not be subjected to the additional restrictions of a "network control signaling unit," and should be allowed to provide dialing, answering, and control functions if properly constructed. If you support this view, write the ARRL. The FCC sometimes listens to the voice of amateur radio. Possibly, a good quality phone patch could be used as a supporting exhibit. In any case, make your opinions known.

The phone patch is a useful piece of equipment, and now it's legal. Let's keep it that way.

...W5LHG

Will Amateur Radio Win the Technology Race?

Ham radio is becoming extremely technical, what with SSB, VHF, UHF, SHF, Moonbounce, Pulse, Masers, Lasers, etc. Unless the convictions of most amateur radio operators change drastically, technology may destroy ham radio.

As an 18-year old electronics engineering student, I have been observing the more experienced operators above the age of thirty, most of whom have become content to possess their general license and just chew the rag. Few will admit their stagnation, but only a handful of "go-getters" are advancing ham radio technically. And even fewer are keeping up with the advancement. Many SSB operators really do not even understand the technique of SSB generation!

Just take a look at the bands above 50 MHz. Only on the frequencies where commercial equipment is available are there any large-scale operations. The majority of ham radio is not willing to explore the upper region, either due to lack of knowledge or lack of initiative.

Now I am not professing to be an electronics genius, but I am not content to pass the test and take a rest! After four to eight years of college, I plan extensive study of radio technology, far beyond what is expected of the average ham.

What I am advocating, however, is not for all amateurs to study college courses. This is too much to expect. But at least be able to understand your present rig. Try to keep pace with the moderate theory. Maybe, if you keep active, both on electronics theory and on the air, you'll be a better ham. Remember, amateur radio is not CB. We are supposed to lead in technology and experimentation, not follow.

Roy C. Pollitt, WA3IID

A Direct-Reading SWR Indicator

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The direct reading swr indicator.

The device described here was conceived as a result of my somewhat frustrating experience in tuning an antenna matching circuit. The procedure usually recommended goes something like the following:

1. Tune up the transmitter into a dummy load of the proper impedance.
2. Remove the dummy load and connect the antenna matching unit to the transmitter through the SWR bridge.
3. With SWR bridge set to forward (FWD) position and transmitter energized, set the meter pointer to full scale.
4. Switch the SWR bridge to reflected (REF) position, and adjust antenna matching unit for minimum reading on the meter.

This sounds simple enough, but all too often the REF reading is decreasing because the transmitter output is decreasing as a result of mismatch. To guard against such a condition after an adjustment is made, the SWR bridge must be set to FWD, the meter adjusted to full scale, and the SWR bridge again switched to REF. Hopefully, the SWR has been decreased, but this is not always the case. What is involved, then, is a repetitive cycle of setting the meter to full scale in the FWD position, switching the bridge to REF, making an adjustment to decrease the reading, and then checking the result. This can get pretty frustrating after a while. There should be an easier way, and there is.

What is needed is a way to compare the forward and reflected readings continuously while making the adjustments to the matching unit. Of course this could be done by using two meters to show forward and reflected power simultaneously, and adjusting everything to maximize the reading on the forward meter while minimizing the reading on the reflected meter. I feel that the device described here is even simpler to use and it requires only one meter. Basically, it is a voltage comparator, as shown in **Fig. 1**. The meter should have a high impedance for best results. This circuit has some limitations.

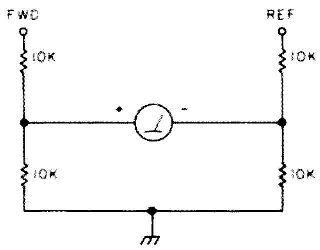


Fig. 1. A simple voltage comparator. This circuit has some limitations since a false swr reading may result depending on power.

For example, there is no way to determine what the SWR is; that is, high power with high SWR may give the same reading as lower power with low SWR. This limitation is removed in the circuit of **Fig. 2**. The SWR calibrations on the usual SWR indicator are computed from the following equation: SWR = (FWD + REF) / (FWD - REF). As an example, if we let 10 represent a full scale reading, and adjust to full scale with the bridge set to FWD, and switch to REF and get a half-scale reading (5) the SWR is (10 + 5) / (10 - 5) = 3.0. For the same case, using the circuit of **Fig. 2**, the voltage at point F will be twice that at point R. If we now set R1 to its midpoint, the meter will read zero. It now becomes obvious that R1

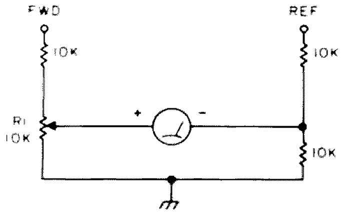


Fig. 2. The direct reading swr indicator which gives more accurate results.

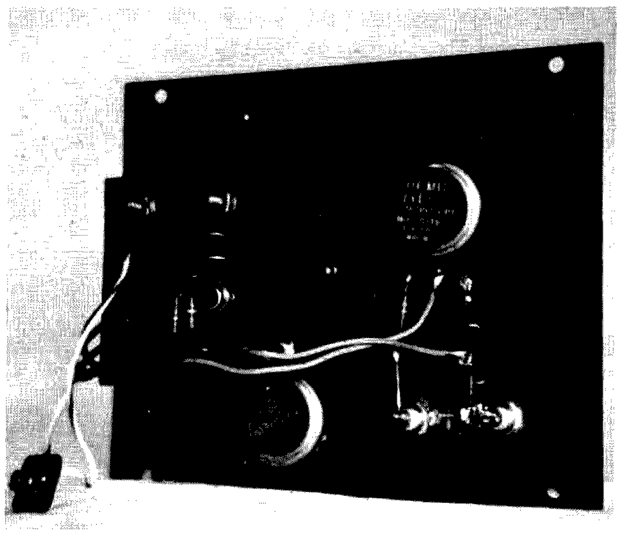
can be equipped with a dial calibrated in SWR; i.e., the midpoint would correspond to SWR = 3.0. The dial can be calibrated by use of an ohmmeter as follows:

SWR	Resistance (from ground end)
1.0	0
1.2	909
1.5	2000
2.0	3333
3.0	5000
5.0	6667
10.0	8182
20.0	9048
00	10000

The meter used in my version is a 1 MA movement with a transistor amplifier similar to that described in January 1966 issue of 73. The meter amplifier was built on an etched circuit board for mounting directly to the meter terminals. The meter scale is arbitrarily calibrated with zero in the center. A resistor (82K) is used in series with the base lead to prevent changes in the zero-set when R1 is varied. My bridge has a positive output. If the one to be used has a negative output, the meter should, of course, be reversed.

The use of this device is extremely simple. The transmitter is first tuned up using the dummy load. The antenna matching unit is then connected to the transmitter through the SWR bridge. The meter is set to zero, and the transmitter is then energized. Adjusting R1 to bring the meter back to zero will then enable the SWR to be read from R1's dial. After this, any adjustment of the antenna matching unit which causes a more positive meter reading on the SWR indicator is in the right direction. The *amount* of increase in meter reading is a relative matter, depending not only on the SWR but also on the transmitter power. If the operator desires to determine the new (improved) SWR, he need only adjust R1 to bring the meter back to zero and read off the SWR from the calibrated dial.

Of course, the use of the direct-reading SWR indicator is not limited to tuning antenna matching networks. It can be used by anyone who would prefer its simplified SWR readout. If R1 is set to a higher SWR than that actually existing, a positive meter reading results, and the transmitter can be tuned for maximum output by maximizing the reading, just as in using the conventional indicator in the FWD position. ...K3WRW



A look at the interior. Obviously a simple device to build.

Asymmetrically Feeding Long-Wire Antennas

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Changing the location of the feed-point on long-wire antennas can make major changes in the radiation pattern—changes that can be used advantageously when the antenna placement must remain fixed.

Illustrative patterns and methods to match and determine the feed point impedance are presented.

Many amateurs have room enough to erect an antenna that runs only in a specific direction. This situation may be due to points being available to support the antenna in only specific locations, or an antenna may have to be run in a specific direction because of obstacles, safety requirements, etc. When a wire antenna (doublet feed with a coaxial or a resonant line) is used on the lower frequency bands, the height in wavelengths is normally not very great, and the antenna radiation pattern is very broad—such that stations can almost be worked equally well whether situated "broadside" or "off the ends" of the antenna. On higher frequency bands, however, due to the increased electrical height and length of the antenna, the radiation pattern becomes quite sharp, both in the horizontal and vertical planes. On bands such as 20 meters and lower, one may have room enough to run an antenna that is several wavelengths long. But, if the line of the antenna must lie in a direction that coincides with the direction to a desired area, the signal radiated to that area will be many db below what it would be if a simple ½ λ dipole could be erected at right angles to the long antenna.

Assuming that one can only run a wire antenna in a fixed direction, one has to find some means of changing the radiation pattern to favor a desired area other than that of physically reorienting the antenna. One method that can be used is to asymmetrically feed the antenna. There is some change in radiation pattern when a wire antenna is either center or end fed, but the change is not extremely great (when end-fed, the radiation tends to be emphasized towards the unfed end). However, asymmetrically feeding a long antenna can produce a variety of tailored radiation patterns. One can't completely rotate the radiation pattern to any desired direction, but it is possible to at least develop useful radiation in directions that aren't covered by a symmetrically fed antenna or to produce a reduction in the response of the antenna towards a direction from which interference originates.

Effect of Asymmetrical Feed

The horizontal radiation pattern of a horizontally placed wire antenna is determined by the current/phase relationships in various sections of the antenna. When the antenna is symmetrically fed, a symmetrical horizontal radiation pattern results, such as is shown in **Fig. 1**. The cloverleaf-type pattern shown in **Fig. 1** results whenever the total antenna length is more than about 3/4 λ; otherwise, the main radiation is broadside to the line of the antenna. As the antenna is made longer in terms of wavelength, the lobes of the cloverleaf pattern become sharper and have a peak intensity at an angle closer to the line of the antenna. Sharp secondary responses also appear, some of which can have the radiated intensity of a dipole at its maximum orientation.

If one had a 3 λ long antenna which produced the horizontal radiation pattern shown by the solid line in **Fig. 1** and found that this pattern produced poor results in certain directions, **Fig. 2** shows some of the solutions

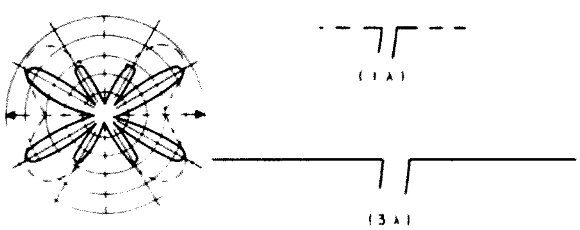


Fig. 1. The horizontal pattern of a 1λ long symmetrically fed antenna (dotted lines) and a 3λ long symmetrical antenna.

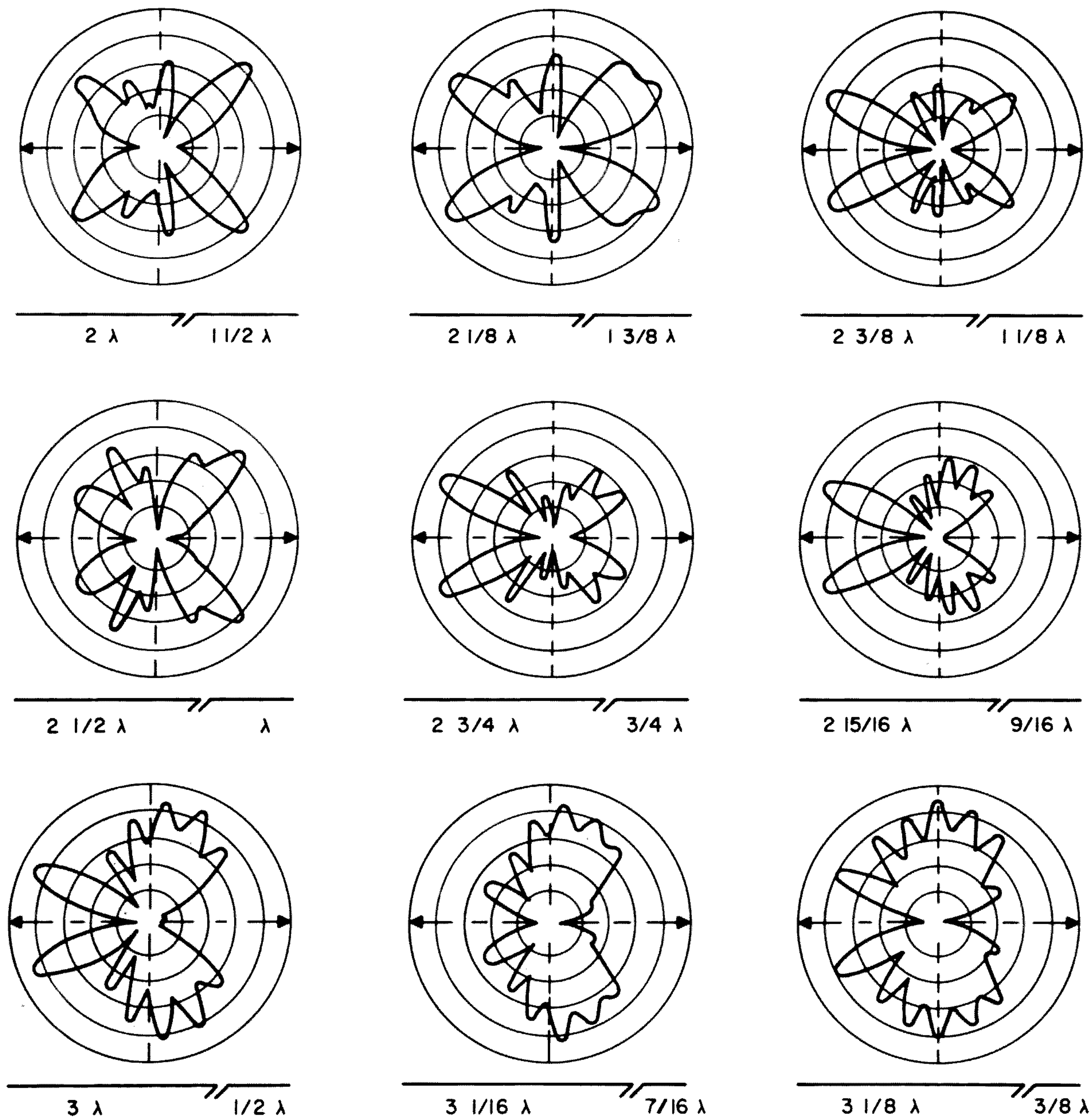


Fig. 2. Changes in the horizontal pattern are illustrated as the total length of an antenna (3½λ) is held constant, but the feed-point is moved gradually toward the right.

that asymmetrical feed can offer. Note that the horizontal patterns in **Fig. 2** are produced as the total antenna length remains constant and the feed point is moved towards the right. The same form patterns but with mirror responses would be produced if the feed point were moved toward the left.

Particular patterns deserve note, and it should be apparent as one studies the diagrams that in some cases very little change is required in antenna dimensions to produce significant changes in the pattern.

As the short side of the antenna is decreased slightly in length, some broadening of the main lobes occurs and the sharp second-responses are more filled in. The peak response of the main lobes changes from about 20 degrees to 45 degrees as measured from the line of the antenna. As the short side is reduced to 9/16 λ, an almost unidirectional type of pattern forms. A further slight reduction in the "short" side length to ½ λ produces a pattern that can be very useful in many circumstances. Two of the main lobes remain quite sharp and produce some gain while other main lobes have essentially disappeared from their usual location, thus leaving a deep null for about a 60 degrees arc in

one direction. Other responses produce a fairly full response broadside to the line of the antenna. Such an antenna pattern might be useful if one wanted to concentrate radiation in an easterly or westerly direction (producing a good null in the opposite direction) and still have a reasonable amount of north-south response. When the "short" side is reduced to either 7/16 or 3/8 λ, primarily broadside radiation takes place. Such a response would be ideal for the fellow who moans that he can't work anyone in a direction broadside to the line of direction of his long-wire antenna.

The patterns shown are only exactly true for a frequency or band where the antenna lengths are the electrical lengths shown. They do change with frequency. However, as a general approximation, they still will retain the same general shapes when, for instance, the 3λ antenna is operated on a frequency such that its electrical length is 1½λ. As the total electrical length of the antenna is made shorter, varying the feed point placement has less effect upon the horizontal pattern. It probably is not worthwhile to experiment with asymmetrical feed to vary the antenna pattern when the antenna electrical length is less than 1λ.

Feed Point Impedance

As the feed point is varied, the impedance presented will also vary. The range of variation depends upon such factors as the antenna element/wavelength diameter ratio and can go from 50 ohms to a few thousand ohms with thin-wire antennas.

One could simply feed the antenna with a resonant line such as 450 ohm open wire or twinlead and employ an antenna coupler at the transmitter end to derive a low impedance, non-reactive load for the transmitter. A transmatch coupler will easily handle the range of impedances encountered, for instance, and provides a handy means for multiband coupling to the antenna.

For those interested in single band operation and/or using a non-resonant feedline, the antenna impedance that must be matched can be calculated without too much complication. To a close degree, the feed point impedance of an asymmetrically fed antenna is one-half the combined impedance of two symmetrically fed antennas whose half length is equal, respectively, to the length of each side of the asymmetrical antenna. Some examples should make this calculation clear.

Suppose that an asymmetrically fed antenna is used having a "short" side of ¼λ and a "long" side of 3¼λ. The feed point impedance will be one-half the added feed point impedances of a symmetrical ½λ and 6½λ (13/2λ) antenna. The center impedance of a ½λ antenna is about 70 ohms and that of an odd multiple ½λ is the same, or also 70 ohms for the 13/2λ antenna. The combined impedance is 140 ohms, half of which is simply 70 ohms—the same as for an ordinary ½λ dipole. In this special case, an ordinary 50 or 70 ohm coaxial line can be used to feed the antenna directly, with the addition of a 1:1 balun, if desired, to preserve the feed-point balance.

As another example, slightly more complex, consider the situation if an asymmetrical antenna were used having a "short" side of 3/8λ and a "long" side of 3 1/8λ. To find the feed-point impedance, it is first necessary to determine the feed-point impedance of a symmetrical 3/4λ and 6¼λ antenna. These can be determined from the graphs shown in Fig. 3. The curve is used which corresponds to the wire diameter/wavelength ratio of the actual asymmetrical antenna. In this case, a λ/1000 ratio is assumed, which is slightly large for a wire antenna operated on ten meters, for instance, but close enough to produce meaningful results. Then, the center impedance of the 3/4λ symmetrical antenna is found to be about 500 ohms resistive and +500 ohms reactive (500 + j500). The center impedance of the symmetrical 6¼λ antenna cannot be read directly, but since the impedance values repeat every wavelength, the impedance value of the 6¼λ antenna is approximately the same as a 1¼ or 2 ¼λ antenna. From the graphs, the impedance value is 150 ohms resistive and -500 ohms reactive. The center impedance of the asymmetrical antenna is: $Z=½(500+j500+150-j500)=½(650)=325$ ohms.

In this case, the reactive portions of the two symmetrical antennas are equal in magnitude but opposite in sign, so they simply cancel. The resultant resistive 325 ohm feed-point impedance would offer a good match to a 300 ohm twinlead feedline, or the antenna could be fed via a 4:1 balun with 75 ohm line, thus taking care of the impedance matching problem and preserving the feed-point balance simultaneously.

The choice of other "short" and "long" lengths for the asymmetrical antenna may not, of course, offer such simple feed-point impedances. In such a case, one can either build a matching network to allow coupling to the antenna by a non-resonant feedline or accept some slight change in the radiation

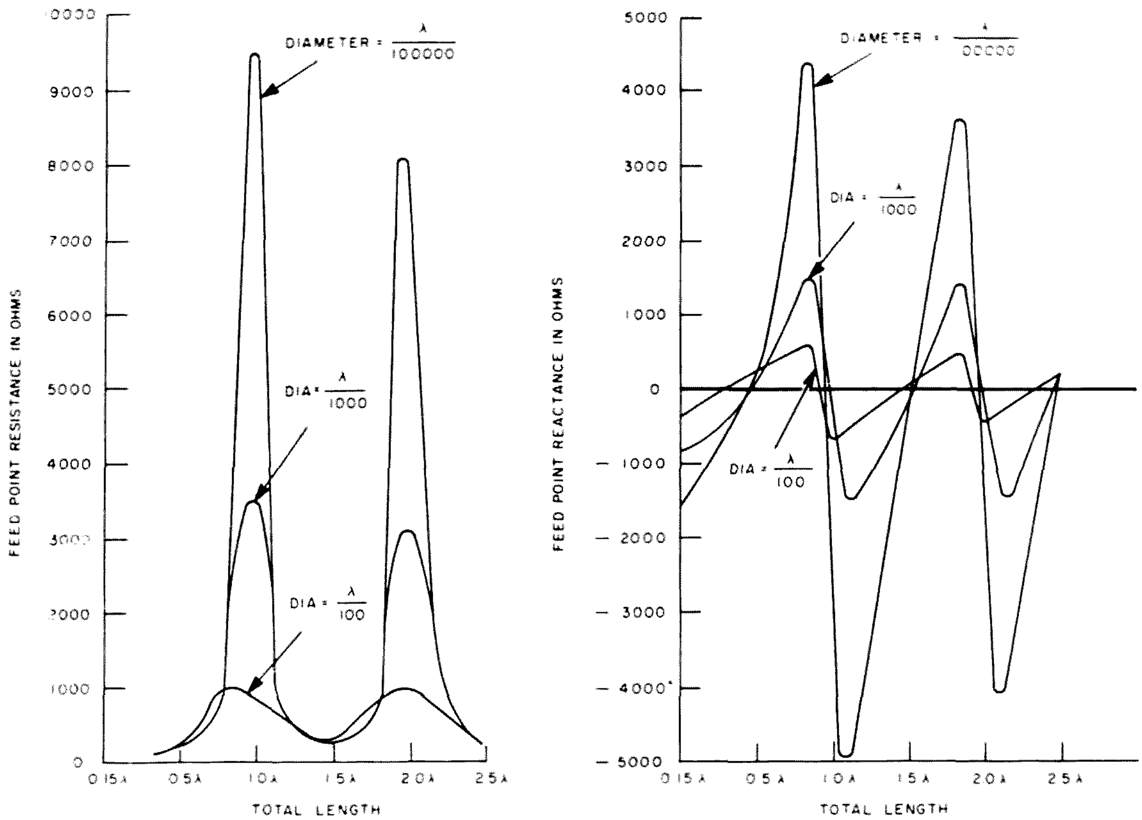


Fig. 3. Graphs of the feed-point resistive and reactive components of a symmetrical, center feed antenna. As explained in the text, these graphs can be used to calculate the feed-point impedance of an asymmetrical antenna.

pattern and use the closest "short" and "long" lengths which provide a convenient feed-point impedance.

Summary

So many factors affect antenna directivity, both in the horizontal and vertical planes, in a given actual installation, that only using the antenna can disclose its true performance. If, however, a long-wire antenna does exhibit dead spots in a particular direction or if it is desired to reduce the level of interference from a certain direction, asymmetrical feeding of the antenna offers a possible solution with extremely little effort and cost.

For those who would like to experiment and know something of transmission line stub switching, it is possible to develop, using the principles presented, a dual feedline antenna with a selectable pattern. When not used as the power transmission line to the antenna, the alternate feedline would be shorted to reflect a direct continuity of the antenna flat-top. To accomplish this, of course, the feederline length would be a multiple of ½λ.

With some imagination, the long-wire antenna can be turned into a versatile radiator. The operator who has room enough to erect one or, indeed, can only erect such a radiator should not discount its possibilities too quickly.

...W2EEY/1

Growing Beams In The Basement

It is a sad fact that most antenna "theory" is really empirical observation. Any ham who has tried to concoct his own antennas can vouch for the fact that no matter how good a design works on paper, the tinsnip and hacksaw test is the only one that really counts. So why not build them all? Before you start buying stock in an aluminum parts factory, consider this idea to minimize your cost and maximize your gain.

For years the aviation industry has used model planes to guess what might get off the ground and not fall apart. Similarly, model antennas can be used to find out cheaply which designs are likely to give good results and which should be slated for the trash. First select the highest frequency for which you can build a small oscillator. You don't need to get too wild, something between 500 and 1000 mc will give you a halfwave length that will be workably small. To keep peace with the local populace it would be a good idea to find one that doesn't interfere with TV.

The transmitter is a simple oscillator of whatever type is easiest to build. It is coupled to a simple halfwave folded dipole by a piece of 300 ohm TV ribbon. For greater effective power a shaped screen or dish can be placed behind it. The receiver is just a diode, a capacitor, a sensitive microammeter, and a variable resistor. At K9BDO we used a lab interferometer and obtained several promising designs for driven arrays.

Generally, this test system works well for determining the radiation patterns, front-to-back ratio, and gain of antenna designs. It can be used to find both the vertical and horizontal patterns, which is hard to do on full size antennas. It would be a good idea to make a dipole and a three element beam to serve as standards of measure. One thing that cannot be measured accurately is impedance, due to the effects of random capacitance and inductance. A lower frequency, such as six meters, must be used to make these measurements.

Materials for your donation to the world of invention can be almost anything, but I recommend aluminum clothesline and some pieces of soft wood. With this equipment almost anyone can embark on a career as an amateur antenna designer; and if you fail at that, you can always try writing articles.

David B. Cameron, WA4VQR

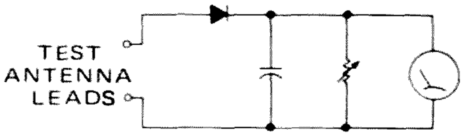
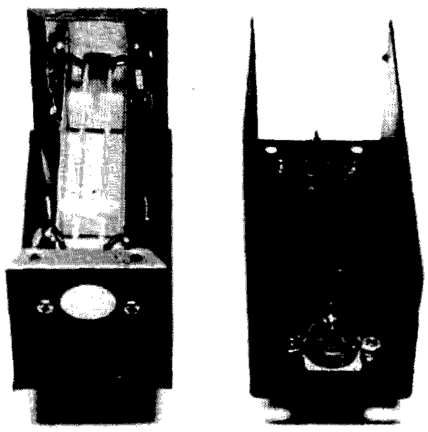


Fig. 1. The test system consists of a simple receiver with a diode, a capacitor, a microammeter, and a variable resistor.

Rear Connectors for That Imported SWR Bridge

One of the best all-around values on today's ham market is the $10 imported SWR bridge. But a shortcoming of these units is that the connectors are obtrusively placed on the ends of the unit rather than on the rear. In use the unit is not nearly as compact as it looks. Fortunately, it is a simple matter to move the connectors to the rear.

Begin the modification by removing the back. Note the pieces of insulating plastic and cut vertical slits as indicated in the photograph. Unsolder the middle rod at each end and lift it straight out. Carefully remove the PL-259 connectors. Now cut two pieces of scrap aluminum 1"x1½". Drill the appropriate holes and mount the pieces to take the place of the two removed connectors.



The modified SWR Bridge with connectors on the rear.

Mount the PL-259s on the rear cover, centering them 11/16" from the end. Place the center rod atop the terminals and solder. The center rod should now occupy the same position as before, but soldered to terminals on the rear. Replace the cover, and the modification is complete.

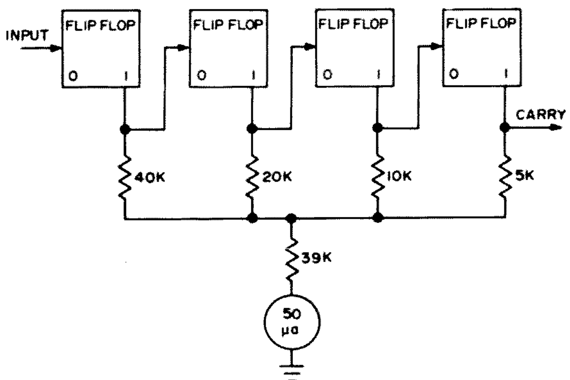
While accuracy on 6 and 2 meters and sensitivity in general may suffer slightly with the rear connector arrangement, few would deny the obvious advantages of the modification.

James C. Miller, III, WA4IQD

Add This Simple Decimal Readout to Your IC Counter

An integrated circuit counter is a pretty satisfying project and I can find no primrose paths in Wes Votipka's article in November '68 "73" magazine. One somewhat "un-American" (whatever *that* means) aspect of the counter described is that binary readout – you must sum the values of the lights on in each decade to translate. There is a fine excuse for this approach if illuminated readouts are required – in each decade four lamps and drivers do the job of ten lamps (nine, if zero is understood), drivers and a binary to decimal translator. If a diode matrix is used to translate, forty *good*, high back-resistance diodes are needed for each decade!

Now, my counter is not finished but perhaps my readout system will be of interest to others still in the building stage. This low cost approach gives a true decimal readout. I use a separate meter to indicate the output of each decade – 50 microampere meters function very well when connected directly to the outputs of 923 type flip flops. The trick is to properly weight the current passed to the meter by each flip flop of the decade. The circuit I've used is shown in the figure.



Note the binary relationships among the resistors – the least significant binary digit can only introduce one half the current supplied by the next more significant digit and so on. Logic levels of individual flip flops will be different, so equal increments of meter deflection will probably not be observed. However, the meter will assume very distinct positions for each count stored in the decade. Purists can trim resistance values to equalize deflection increments – I'm satisfied to let the chips fall where they will and mark the meter scales accordingly.

If there are some misgivings about cost – 50 microampere meters are seldom the cheapest on the list – imports go for about $3. Being pure Scotch I managed to cut that by picking up a batch of brand new photographic light meters from Olson Electronics in Akron, Ohio, at two for a dollar! These are 54 microampere movements and, though not cased, are beautifully made. I haven't tackled the mounting problem but it doesn't appear too difficult. Earl Bryant WA7EYR

San Francisco, Here I Come!

In connection with the hearing on the Miller suit, I will be in San Francisco from May 26th through the 30th. If any clubs in the area are interested in having a guest speaker with a lot to say, please drop a note to me at 73 telling me which night you like. Questions answered on anything and everything, if you really want to know what's going on.

Wayne, W2NSD/1

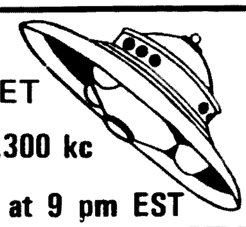
For Your Next Converter

Good old Sears & Roebuck has done it again. How many times have you battled with copper flashing material–trying to get it to take solder, attempting to form it into some reasonable facsimile of a box or VHF cavity? If you're tired of burned fingers and torch-soldering, take heart. Rush down to your nearest Sears & Roebuck store and invest about $2.50 in a roll of their Zinc-Copper alloy flashing. It comes 1 foot wide, and the rolls are 10 feet long. That's a lot of converters!

It takes solder beautifully. You can lay a bead with only a gun–no more torches. It forms easily, and cuts with standard scissors, or with a paper-cutter. In VHF and UHF applications, it performs at least as well as copper flashing–and it silver plates easily, to boot.

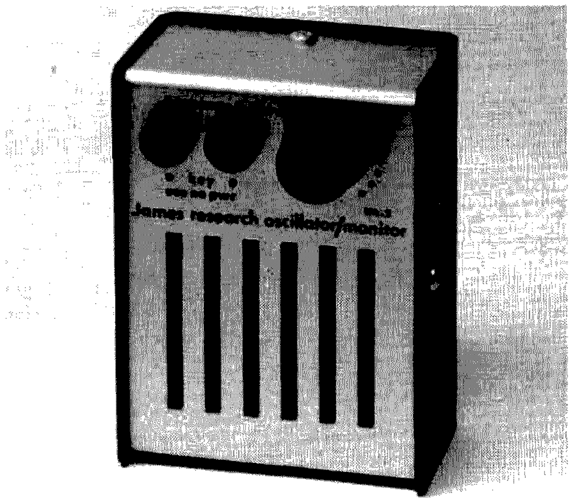
Thanks to Jay, K8CJY, for tipping me off to this great stuff!

Bob Grenell, W8RHR



73 Tests

The James Research Oscillator/Monitor, Mark 2 and Permaflex Key



Oscillator/Monitor is a very modest description of this extremely versatile piece of equipment. Housed in an anodized aluminum case about the size of a pack of cigarettes, this little unit does just about everything except stand up and sing "The Star Spangled Banner."

The Mark 2 will serve as a CW monitor, a code practice oscillator, an *rf* detector, an *rf* test device, and a test instrument to check diodes and semi-conductor devices of all types.

CW monitoring

The Mark 2 provides a reliable CW sidetone from any amateur transmitter regardless of power or frequency. It requires no connection to either the transmitter or key. An 8" stiff wire antenna picks up stray *rf* and triggers the monitor. A strong magnet is attached to the back of the case to allow it to be placed on the transmitter in the spot where the *rf* pickup will be best.

Code practice

The monitor can be connected to any keying device to produce a loud, click free audio tone. A tone control knob allows for adjustment to a comfortable listening tone.

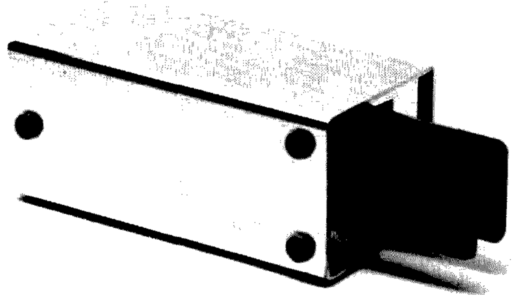
RF detection and testing

The high sensitivity and broadband characteristics of the monitor make it a valuable *rf* test instrument. It will detect the presence of *rf* by producing an audible tone and indicates relative power of the *rf* source by changing tone. No direct connection is required for *rf* in excess of 10 milliwatts. The monitor may be used as an effective tuning aid for transmitters or power oscillators. As the *rf* power increases, the tone becomes lower in pitch.

Component continuity and semi-conductor testing

For the testing of circuit or component continuity, the monitor has many advantages. Tests with the monitor are completely nondestructive since the power required can never exceed .0025 microwatts and the open circuit voltage is not over 1.5 volts. The maximum current that can pass through any component will not exceed 50 microamps. The monitor will test component resistances from zero to 100,000 ohms. Various resistance values will cause the tone of the monitor to change. It is possible to test for open or shorted conditions as well as partial continuity. Since the monitor is a polarized device, it will test such polarity sensitive components as semi-conductors and meters.

Available by direct mail only at the Miniprice of $14.95.



Permaflex key

The James Permaflex key is a manually operated single pole double throw switch

mechanism. It has two independent insulated contact paddles mounted to a contacting center support arm. The key is operated by light finger pressure against either of the two paddles. The key can be used with any electronic keyer or may be connected directly to a transmitter. The contacts are rated 8 amps at 28V dc which is far in excess of most transmitter requirements and are the heart of the key design since they eliminate the usual corrosion and cleaning problem associated with traditional silver contacts.

The silver contacts have a gold diffused coating.

The key is housed in a polished chrome-plated steel cabinet 1 9/16" square by 3 3/4" long and total weight is 10 oz. There are two independent sets of rubber feet. When one set is used, the key operates as a side-swiper type of key. When turned to the other set of feet, it can be used as a straight hand key. Selling for $19.95, it is hard to find a more versatile key.

All James Research products are designed and manufactured in the USA and are available by direct mail order only. They carry a one-year guarantee. James Research Co., Dept. AR-M, 11 Schermerhorn Street, Brooklyn, N.Y. 11201.

A "Compressed" Vertical for 160

This antenna requires only half the height of a true quarter wave vertical.

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It is not the purpose of this article to go into the relative merits of horizontal and vertical antennas for 160, but rather to present an interesting and practical design for those amateurs who would like to try a vertical without going to excessive heights or resorting to critical loading gimmicks. As is well known, a true quarter wave vertical for this band would require a height of at least 120 feet or so, which is usually out of the question for most amateurs. The antenna described here requires only half this height and as far as I can tell by experiment, the radiation efficiency is about as good as that of the full length antenna.

The basic design of the antenna is shown in Fig. 1. About the same conductor length is used as would be needed for a full length vertical. Also most of the horizontal radiation is cancelled by the adjacent horizontal sections of the radiator as shown in the figure. Complete cancellation will, of course, not be obtained since the antenna currents in the adjacent horizontal sections are not quite equal and opposite. However, on-the-air tests at night have consistently shown less QSB than that obtained from horizontal antennas, which seems to indicate that the antenna does behave like a true vertical.

The antenna is built most simply by stapling insulated wire to a wooden mast. Do not use a metal tower or mast. The antenna support I used is shown in Fig. 2. The mast is pivoted at the roof level with the lower third extending towards the ground as shown. Six bricks in a pail are used as a temporary counterweight whenever it is necessary to raise or lower the antenna. Two guy wires as shown were found adequate since no high winds are experienced at this QTH.

The first experimental antenna built used no. 12 weatherproof outdoor wire arranged

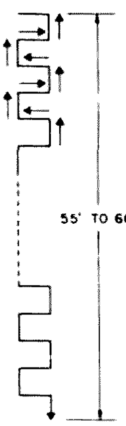

Fig. 1. Basic antenna wire layout. (Arrows indicate instantaneous current flow and cancellation of horizontal radiation.

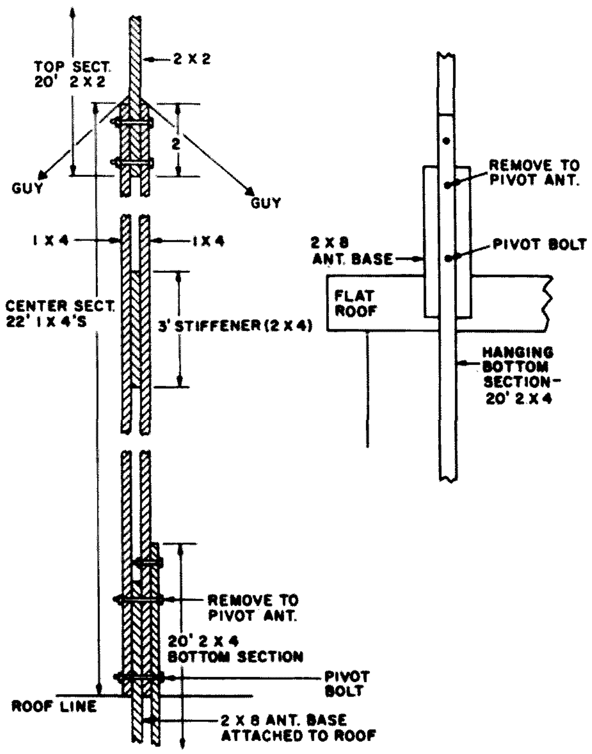

Fig. 2. Antenna support.

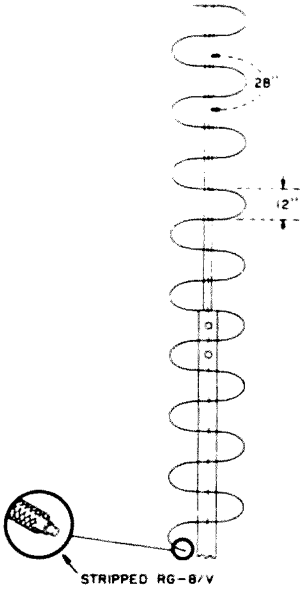

Fig. 3. Antenna configuration using stripped RG-8/U.

in 6-inch squares as shown in Fig. 1. It was about 32 feet high and proved quite effective on 75 when worked against ground as a quarter wave vertical. The second and final antenna was made from old RG8/U coaxial cable with the outer braid removed. Since the stripped RG-8/U did not lend itself to a square configuration, the antenna was made in a series of loops as shown in Fig. 3. With the dimensions shown, the antenna resonated at 2150 kHz against ground.

This was a little high for the frequency of interest (1990 kHz) and would have required making the antenna about four feet longer. Since I was out of lumber as well as energy, I decided to use a simple series tuned antenna coupler as shown in Fig. 4. The coupler was also satisfactory for tuning to the 1900-1925 kHz segment of the band. The simplest way to adjust the antenna system is to "grid dip" the tuner to the operating frequency and then use the transmitter pi network to load the transmitter in the normal manner.

I had no luck loading the transmitter "pi" network directly into the antenna because the antenna impedance was too low for the "pi" network–about 30 ohms as measured on an antennascope. No attempt was made to feed the antenna with a transmission line, since the antenna base and ground were both located right outside the shack window.

This antenna, like all quarter wave antennas requires a good ground system. Radials, of

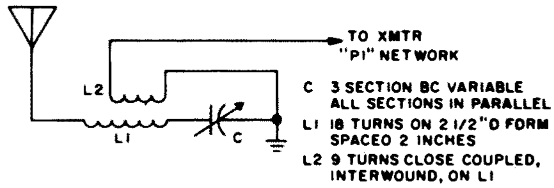

Fig. 4. Antenna Coupler.

course, would be best if you have the space and the energy to install them. I used three eight-foot ground rods in conjunction with three water pipe ground connections, all tied together. The antenna current was the same whether a half wave or quarter wave antenna was used, so I assumed that the ground system was fairly efficient.

As for results obtained with this antenna, I have had neither the desire nor the ambition to operate odd hours and check the antenna on some real DX. However, tests run with stations 250 miles or so out indicate a two S-unit gain at times over a low horizontal antenna. Strangely enough, stations closer in (40 miles or less) favor the horizontal

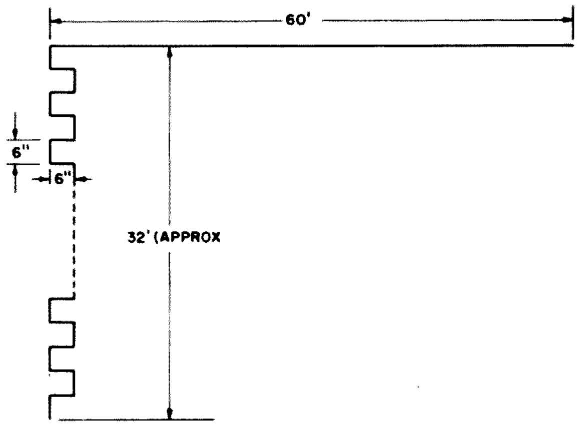

Fig. 5. Inverted "L" configuration.

antenna by two S-units or so. Excellent reports have also been received when working Idaho and Wyoming stations from this QTH with 50 watts input.

For those amateurs who think 60 feet or so is still too high for an antenna, I suggest an inverted "L" configuration as shown in Fig. 5. The antenna is, in effect, a 1/8 wave vertical with a 1/8 wave horizontal wire added. It has given a good account of itself as an all around 160 meter antenna both for DX and local work and is only 32 feet high.

No matter which antenna type you decide to build, you will be sure to have a conversation piece–on the roof, that is.

...W6FPO

Seven-Step Class A Transistor Amplifier Design

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Designing a Class A transistor amplifier is not so hard if you are willing to make a few reasonable assumptions. As a matter of fact, it is just an exercise in Ohm's Law. The biggest assumption is that the transistor has a reasonably high gain, and a reasonably low leakage. This procedure works for NPN, PNP, Silicon and Germanium. You don't care if it is Ge or Si until the 4th step, and if it is NPN or PNP until the last.

If you need a particular gain (voltage gain), you can determine the proper values to get it, or if you want all the gain you can get, take the same procedure, but bypass the emitter resistor. Refer to **Fig. 1** for the seven steps and an example to show how they are used.

Once you have designed the amplifier and assembled it, check Vc. It should be about one-half the supply voltage. If it isn't, change RB2. Increase it if Vc is too low, or vice versa. If you build for a set gain, remember to allow for the loading of the next stage by figuring the load in parallel with RL in step 2. If you decided to go all out for gain, pick CE to have a reactance of about one-tenth the value of RE at the lowest frequency you plan to pass through the amplifier.

This procedure will allow you to design a workable amplifier for almost all applications for Class A RC coupled amplifiers. You may come upon a special case, but I have developed this procedure while working in various Engineering Departments during the last three years, so I sincerely doubt it.

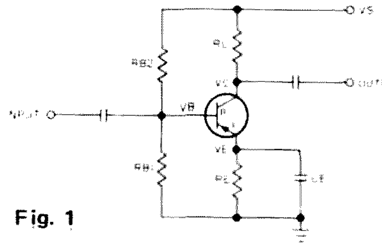


Fig. 1

1. Pick RL (.6-20K) IC=.5VS/RL
2. Calculate RE (Gain 1-25) RE=RL/Gain
3. Calculate VE (IE about equal to IC) VE=IC(RE)
4. Add VBE to VE to get VB. VBE=.3v for Ge, .6 for Si VB=VE + VBE
5. Pick RB1 (3.3-27K)
6. Calculate RB2 RB2=RB1(VS-VB/VB)
7. If NPN, VS is Positive If PNP, VS is Negative

Example: NPN Si, 12VDC, Gain of 10

1. RL=10K, IC=6/10K=.6 ma
2. RE=10K/10=1K
3. VE=$.6\times10^{-3}\times1\times10^{3}$=.6VDC
4. VB=.6+.6=1.2VDC
5. RB1=12K
6. RB2 in K ohms RB2=12(12-1.2/1.2)=12(9)=108, use 110 K
7. VS is Positive

Additional Remarks

Step 1: To be able to get the maximum voltage swing out before clipping, the collector needs to be set one-half the effective supply voltage below supply voltage. To find effective supply voltage, subtract VE from VS. Then drop half of that across RL.

Step 2: This step presumes that the gain of the transistor is higher than the gain the circuit asks for. Normally this will be the case. If you want all the gain you can get, bypass the emitter resistor. This will increase the distortion somewhat. Usually the distortion will still be low enough for amateur purposes, but not low enough for "Hi-Fi".

Step 3: Since the base current is small compared to the collector current, this is a good approximation. It is not advisable to ground the emitter directly, as this reduces the dc stability greatly. It also makes this procedure almost useless, since some of the assumptions no longer hold. And one resistor and a capacitor are a very small price to pay for the advantages gained. Also, as a rule, the more voltage you drop across the emitter resistor, the more stable the circuit will be with temperature changes.

Step 4: In actual practice, VBE will not be exactly .2 or .6 vdc, but these values will be very close. The emitter follows the base voltage, and not the reverse, as this procedure might seem to indicate. But this is the simpler way to design the amplifier.

Step 5: No correction has been made for base current, so VB may be slightly lower than this step indicates. The lower RB 1 and RB 2 are, the less base current will affect the result. But this also lowers the input impedance, which makes the amplifier harder to drive.

... WA5SWD/6

Even Better Gamma

In the Sept. '66 *73*, the improved gamma match can be further improved by using the printed circuit board in one piece as in Fig. 1. This makes for a neater job and less chance of wire breakage. K6ZHO's idea is a fine one.

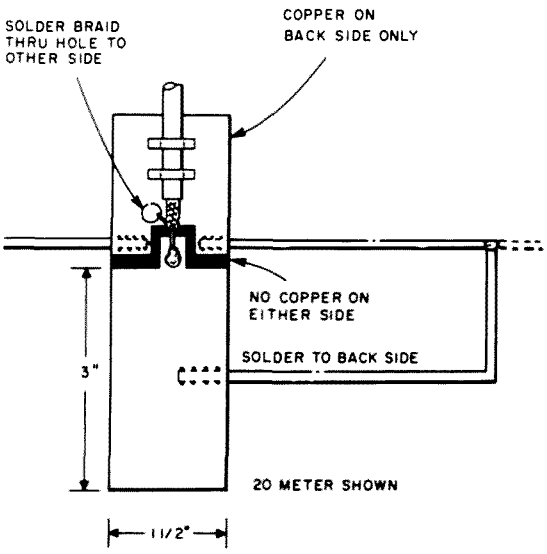


Fig. 1. Details of the improved gamma-match.

The boards should be of either epoxy or polyester. These will absorb less moisture and stand up better in the weather. Newark lists both of these items in their catalog. The epoxy 3x6 is $1.14, # 19F3213. The polyester 3x6 is $ .73, # 19F3228. Kepro is the vender.

Paul A. White, W6BKX

A Cheap and Dirty 15-Meter Antenna for the Longhaul DX

Paul Cook III, WA7CSK
2943 N.E. 178th Street
Seattle, Washington 98155

The $4.98 Novice Special

Parts List:
200 ft. of wire
2–2x4 boards, about 12 ft. long
25 ft. of RG59/U coaxial cable
50 ft. of RG58/U coaxial cable
Electrical tape
Solder
4–egg type insulators

There's no doubt about it, with the sunspot cycle where it is now, 15 meters is the best band for the Novice who wants to work the world. Openings to all continents occur daily, and flea powered Novice stations are picking off the rare DX like shooting fish in a barrel. The word seems to be getting out, and now more and more WN callsigns are heard on 15. When the choice DX moves in on frequency, there are even a few pileups – an occurence formerly reserved for 20 meters. If you want to work *ALL* of the DX with good consistency, you're going to have to have a good signal.

Most Novices today run 75 watts into a simple dipole antenna, but if you want to be "top dog" in the pileups, you'll just have to do one better than the next guy. One way of doing this is to increase your transmitter power beyond the Novice limit of 75 watts. However, that just means big trouble with the FCC, so a better thing to do is to put in a better antenna. In this article I'm going to show you how to build a beam antenna that will beef up your signal so that you can really "sock-it-to-'em" on 15.

The antenna that I am going to describe is called a phased vertical array. It consists basically to two 1/4 wave vertical antennas with 1/4 wave radials placed 3/8 wavelength apart. The antenna is fed with appropriate matching and phasing sections and has a gain of about 6 db. This 6 db of signal improvement is the same as if you changed your transmitter power from 75 watts to 300 watts! The antenna is very cheap and easy to build, and you might have all of the parts, so then it may cost you nothing.

Theory

Basically, the antenna consists of two vertical ground plane antennas placed in "phase" with each other. This means that the two ground planes are placed at a certain distance apart so that the signals from both antennas complement each other and produce higher radiation in one direction. This works the same for receiving. In this way we (1) reduce QRM to stations in other directions because they don't hear us, (2) reduce QRM from stations in other directions because we don't hear them, (3) increase our signal strength in the desired direction, and (4) increase the received signal strength from stations in the desired direction. This all adds up to higher station flexibility and efficiency.

Construction

To build the antenna you will need the materials that are listed in the parts list. The two boards can be mounted on the side of a roof, like my own installation, or mounted on the ground. Before you erect the boards, pound a nail in each end of both. Then measure out 11 feet of wire and connect it to two egg insulators. Do this for both boards, and be sure to solder. Next, take fishline, rope, or what have you, and string up the wires vertically on the boards, tying the insulators to the nails. Then erect the boards. When you do this, be sure that both boards are vertical and 16-1/2 feet apart.

Feedline and Matching Section

Now you have constructed the antenna, and it's time to piece together the matching section and feedline.

Take one 11 foot piece of RG59/U 75 ohm coax and splice it to an 11 foot piece of RG58/U 52 ohm coax, as shown in **Fig. 1a.** Do a neat, careful job and wrap the connection well with electrical tape. If you have some Krylon spray, use it on the connection to do a completely weatherproof job.

Get 11 feet of RG59/U and the RG58/U

Fig. 1A

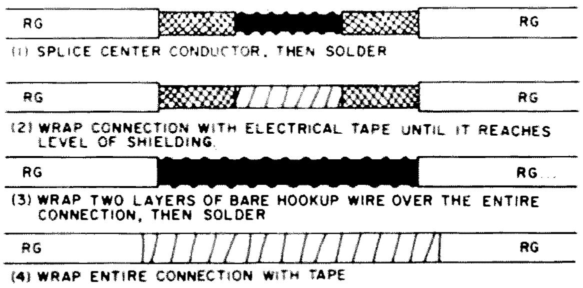
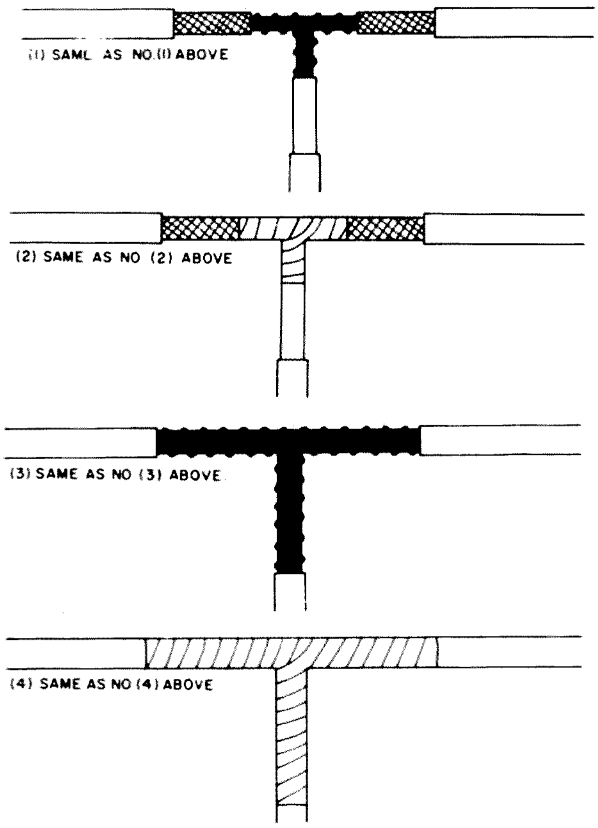


Fig. 1B



that goes to the shack (as shown in Fig. 2) and make the three way splice as shown in Fig. 1b. Here again, if you have Krylon, use it.

Now lay out the matching section on the ground or the roof. Don't coil up the coax or let any kinks get in it. Instead, lay it out so that it lies in a gentle curve with no sharp turns as shown in Fig. 2. Solder the center conductors from the two ends of the matching section to the antenna wires at the base of the boards as shown in Fig. 3. Then solder the outer conductor and eight or more 11 foot ground radials to the nail on each base. Run each radial out from the base fairly perpendicular to the vertical boards and lay

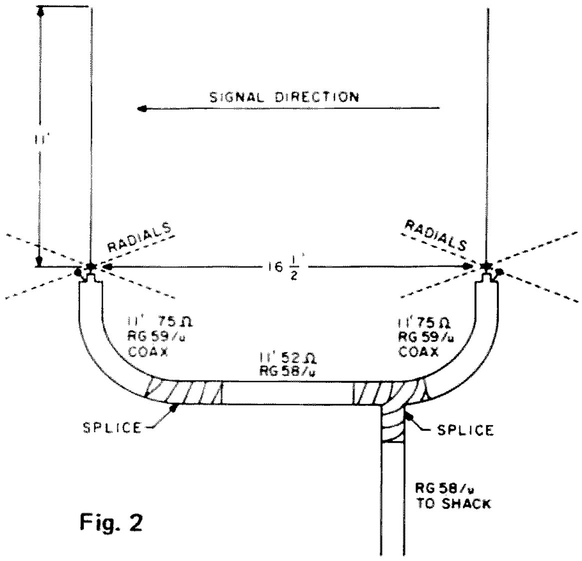


Fig. 2

them on the roof or ground in a fashion similar to the spokes of a wheel. The radials improve the low angle of radiation which brings in the long distance signals better.

Operation

Now that you have completed the antenna, try it out on the air! When I tried mine out with the antenna aimed toward Europe the first time on the air, I knocked off two SM's, a G3, and I1, and a DL with only 75 watts. This little antenna is a real bomb! If you wish to change the directivity of the antenna, then substitute PL-259

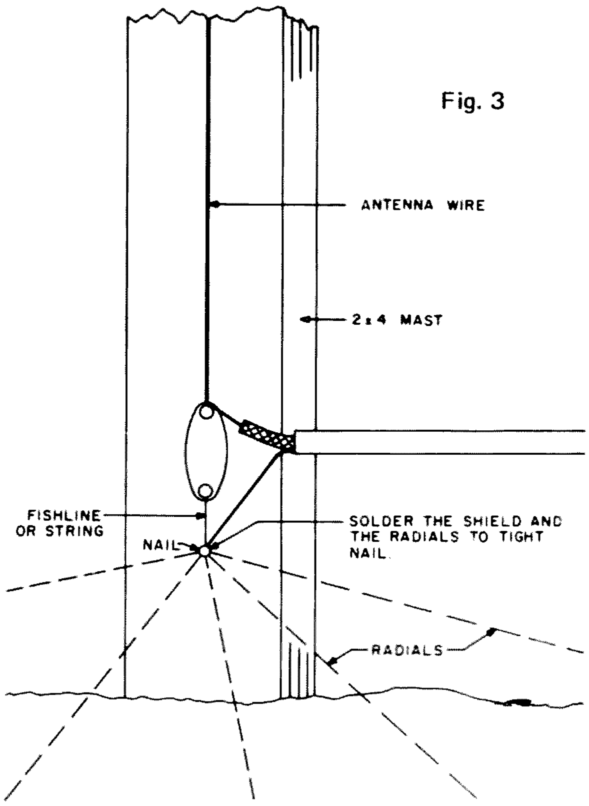


Fig. 3

coaxial plugs, a double female connector, and a Tee connector for the splices. If you connect these as shown in **Fig. 2**, you will have your signal aimed in the direction shown. But if you take the RG58/U matching section out, and connect it exactly the same way, only on the other side of the Tee connector, you will reverse the direction of your signal. If you leave out the RG58/U matching section altogether, you will end up with a figure eight type bidirectional pattern that is perpendicular to the two previous patterns.

In conclusion, if you try this antenna, I'm sure that you'll work a lot of DX. The antenna is efficient and works well, and will help you to get the edge on the other stations. If anyone has any problems with this antenna, please write to me and I'll be happy to advise. If you build this antenna, write to me anyway and tell me how it works!

. . . WA7CSK

FCC ACTS TO REVOKE AMATEUR LICENSES ON OBSCENITY CHARGES

The Federal Communications Communications Commission took action today to revoke the operator licenses of three Amateur Radio Service operators on charges of obscene, indecent or profane radio communications. The Commission ordered Steven P. Bowman, of Sikeston, Mo.; Kenneth C. Henry of Anderson, Inc., and Gary Overman, of New Castle, Ind., to show cause why their licenses should not be revoked. The three operator licenses were also ordered to be suspended.

In addition to the obscenity charges, other violations included transmission of false or deceptive signals or communications, failure to identify stations properly, transmission of unidentified communications or signals and willful or malicious interference to radio communications of other amateur stations.

The Commission said that the three amateur licensees had repeatedly and willfully violated the Rules. The enforcement actions followed investigations carried out by the FCC Field Engineering Bureau and the FBI after complaints were received from other amateur radio operators.

Actions by the Commission March 14, 1969, by its Chief, Safety and Special Radio Services Bureau. By Orders, and Orders to Show Cause.

How to Fly Your Kite

M. B. Crowley, EI4R
78 Church Street
Listowel, Co., Kerry
Ireland

(Or a vertical long wire on last year's EIØRF Expedition)

The location of the expedition "BEAR" island (rechristened "BEER" island) was good, but the shack QTH was surrounded on three sides by mountains. The problem was to put out sufficient wire for our 1.7 MHz bands; and 260 feet of wire can present quite a problem on such a location. A vertical aerial would be fine, but 260 feet of support pole was out of the question on an island expedition. Gas-filled balloons are not easily come by where we were located. The solution—yes—a kite.

Having in mind from my boyhood days the dimensions of a small kite without frills or tails that, once aloft, in a light breeze could be tied to a convenient peg and forgotten about, it seemed to me that this was the ideal solution.

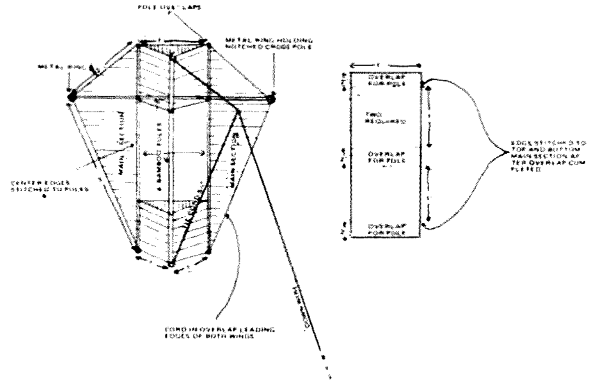
One of our boys gave me some 260 feet of braided copper wire from the old emergency TX "The Gibson Girl" used by aviators in the Second World War. This wire seemed ideal to fly the kite with and weighed only one pound.

Having some half-inch (average) diameter bamboo, garden variety poles on hand, and having persuaded the XYL to let me have some old bed sheets from her junk box, the next undertaking was to scale up the original version of the kiddie kite.

From the diagrams it can be seen that the dimensions and shape are straight forward and present no mathematical problems to scale up to the required size. In my case, this amounted to bamboo poles of 5 feet in length.

The materials required are four bamboo poles, one large section of sheeting and two smaller sections of sheeting. Three lengths of tough light cording are also required. The illustrations give the dimensions of these pieces. When cutting the cloth, do not forget to include that extra width of cloth on the leading edges of the wings, which, when folded back on itself and stitched, will hold the two pieces of cord that strengthen the wing edges.

It would at this stage be advisable to secure the services of the XYL or YL to machine stitch the edging. Go careful here, for this sort of favor could cost you later; why else



do I write this article for 73 Magazine?

The center pieces are stitched with a larger overlap to hold the bamboo poles, which should slip into place with a reasonably tight fit, the ends being then stitched over by hand needle to hold the poles permanently in place.

The overall weight of the kite and poles was 3 pounds. The down wire should be tied approximately a quarter way down the tie cord. Unwind about 50 feet of the downwire and have a helper push the kite up into the wind with the downwire held tight. In a modest steady breeze the kite will lift gently and the remainder of the wire can be paid out. If the kite pulls too hard and slips sideways, tie the downlead further up the tie cord until balance is achieved and the downwire is near vertical. In a light breeze and from the pull on the downwire, it seems to me that this size kite could support about 3 pounds of downwire.

One word of warning. If the breeze is strong, do not allow the junior operator to play around with this size kite. There are easier ways of flying nowadays. Once the kite is aloft, with the required length of wire, tie the downlead to a convenient tie point, through an insulator. A lead to the shack from the tie point will give you a vertical antenna without match, provided the wind remains. Force 9 winds should be avoided as your favorite rig may disappear out the shack window. Happy flying hours, fair winds and tight wires.

...EI4R

Ted Shapas, K9YOE
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Dolton, Illinois 60419

In Search of a Better Angle

Observations and Suggestions Involving HF Radiation Angle Manipulation

When HF DX-getting tactics are discussed, sooner or later the subject will center around antennas, for the antenna, coupled with its geographic positioning, will ultimately make or break a DXer. A status is eventually achieved, however, when the serious DXer has put up the largest and tallest antenna he cared or dared to, or a point of "signal strength stagnation" is reached. For most of us this is a frustrating level, for it probably still means an S-unit or three gap between us and the big guns. Even if you feel you're near the top, however, there were undoubtedly times when these extra db would have come in handy. This article is no magic panacea for combatting a W3CRA or W5VA in the pileups, but knowing a little about radiation angle manipulation may give you something to think about along those lines.

Low angle advantages

I think many of us have operated enough to realize the importance placed upon an antenna with a very long boom perched upon a very high tower. The fellows with the biggest combinations of these two, possibly coupled with an elegant location, constitute the big guns, or the big DXers and contest winners.

A major reason for their seeming invulnerability is the very low vertical radiation angles associated with such an antenna combination. For normal F2 propagation paths, the best situation is for your signal to reach a distant point in the least number of "hops" or reflections. Up to about 2500 miles or so, one hop propagation is possible, but after that, an earth reflection is necessary. Now the signal is being decreased by a number of losses; most pertinent here are distance losses due to spacial spreading, and ground losses at each earthly hop. Distance loss is of course a function of distance; a lower reflection angle means less distance travelled and therefore less loss than a higher angle, although the difference may only amount to a db or two. Much more important are the ground losses. While sea reflections are less critical of incident angle, ground reflections may result in four or five db differences per hop between low and high angles, depending upon frequency (1). Here is one place where the big guns clean up! One or two less of these lossy earth hops experienced by signals approaching from a high angle and we're talking about S-units of difference. Fortunately, all is not this rosy for the people with the low take-off angles.

NBS observations – good news?

The good news is that in most cases, these things I just talked about occur only for "storybook" propagation under ideal conditions. What about the real world? W. F. Utlaut presented an interesting report along those lines in our National Bureau of Standards research journal *Radio Propagation* where he made a detailed study of radiation angle importance. The results were slightly astounding (2).

Using a VOA transmitter in Munich, Germany, and receiving antennas in Boulder, Colorado (a receiver was also located in Slough, England, but results were consistent with those in Boulder), all with carefully calculated radiation patterns, Utlaut attempted to find out if low angles were that

Boulder Antenna	Height ft	Radiation Angle deg
1B	50	15.6
2B	135	5.2
3B	310	2.3
4B	485	1.4
5B	985	0.7

Table 1

good. From March to June, 1959, on 20 MHz, the Munich station transmitted while the receivers in Boulder carefully recorded daily signal variations. Five receiving antennas were used, varying in vertical radiation angle from .7 to 15.6 degrees. Table 1 lists the various antennas, heights, and associated radiation angles, while Figs. **1A**, **1B**, **1C**, and **1D** are graphs of hourly median signal strength for the Munich to Boulder path from March to June. Transmitting antennas at the Munich end were rhombics and vertical main lobes between 12 and 16 degrees (two antennas used).

While receiving data extended through times when the predicted MUF (Maximum Usable Frequencies) were below the operating frequencies, this may be slightly impractical from the amateur standpoint where relatively low power is usually employed. Close inspection of Figs. **1A-D** will bring out a number of interesting points:

1. No one radiation angle dominated for an entire average day during the time the band was open. (MUF greater than 20 MHz.)
2. Low angles seemed more of an asset during a summer month (June) than during a spring month (March). In addition, the spread of signal strength between one angle and another was greater during the summer months than during the spring.
3. Lower angles were characteristically "band openers" with dominance here noted in excess of three S-units over the highest angle.
4. Higher angles seemed valuable during the midday hours, with some advantages over the lowest angle in excess of two S-units at these times. (Remember, these were monthly averages; there were undoubtedly times when these differences were greater.)

The basic observation by Utlaut in this report was that statistically, and over an average 24-hour period, best results could be gained by using the lowest radiation angle possible. This involved times when the predicted MUF was much below 20 MHz; which

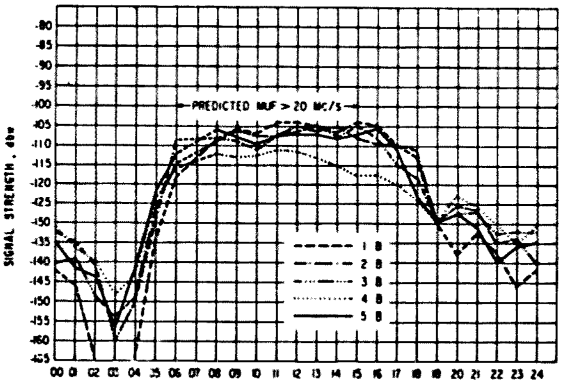

Fig. 1A. Hourly median signal strength for Munich to Boulder path, March, 1959.

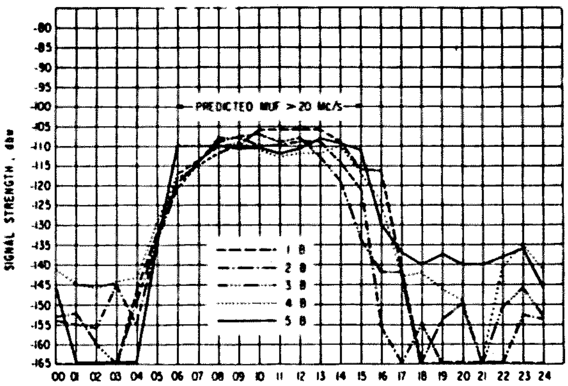

Fig. 1B. Hourly median signal strength for Munich to Boulder path, April 1959.

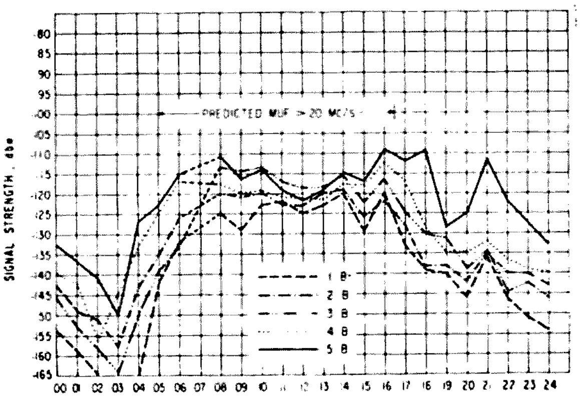

Fig. 1C. Hourly median signal strength for Munich to Boulder path, May 1959.

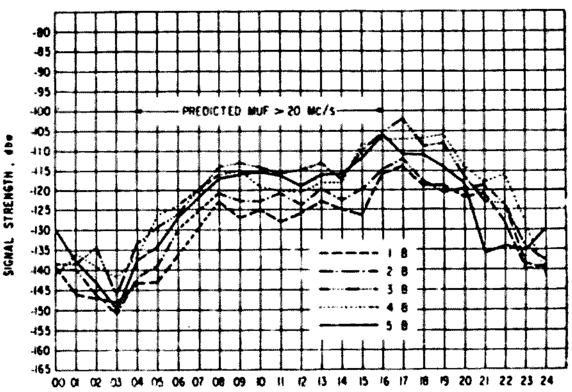

Fig. 1D. Hourly median signal strength for Munich to Boulder path, June, 1959. Transmitter in all cases was off the air from 0600 to 0800 MST. (1)

would probably mean communication below amateur capabilities. Looking at times when the MUF was 20 MHz or above, or when the band was open for possible amateur contacts, seems a slightly different story, with the "best" angle rapidly changing with time. The two most practical antennas, with realistically achievable angles, were 1B and 2B, representing the small time DXer (height 50 feet, angle 15.6 degrees) and the big gun (height 135 feet, angle 5.2 degrees) respectively. Although most differences between these two antennas were in the range of 5 db, special note should be taken of the April graph at about 1600 MST when antenna 1B (small time DXer) had the astronomical edge of 40 db over antenna 2B (the big gun)!

Possible explanations – ray paths and angles

Reasons for such phenomona are varied but usually of a complicated nature; the important point is that they do exist. A possible "easy" answer seems to lie in another recent finding by our Bureau of Standards; while a low radiation angle nets great skip distances, in most cases the absolute longest skip is achieved by a very high angled ray. Fig. 2 illustrates. Ray paths 1, 2, and 3 follow the generally accepted propagation theories – the lower the take-off angle, the greater the distance. Ray 5, however, the highest angled ray before ionospheric penetration takes place, actually out-distances the lowest angled ray! This is apparently the case for most propagation paths, as shown in another NBS graph, Fig. 3. This shows in a general case, that for any skip distance D, two ray paths are possible at any frequency below the exact MUF – either a high or low angled ray. Note, however, that the high angled ray is critically dependent upon the correct angle. Note also, in Fig. 2 again, that the high angle signal is spending much more time in the lossy ionosphere than the lower angles.

Fig. 4 depicts even a more frightening possibility. This is a government ionogram, or graphical picture showing path time ver-

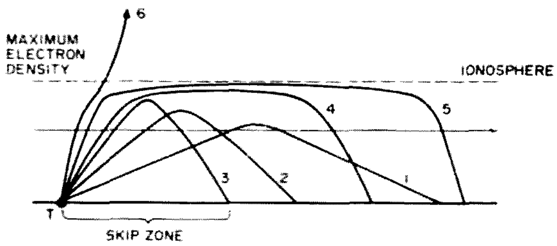

Fig. 2. Possible ray paths at a fixed frequency with varying vertical radiation angle. Note that the highest angled ray, #5, outdistances even the lowest angled ray, #3. (2)

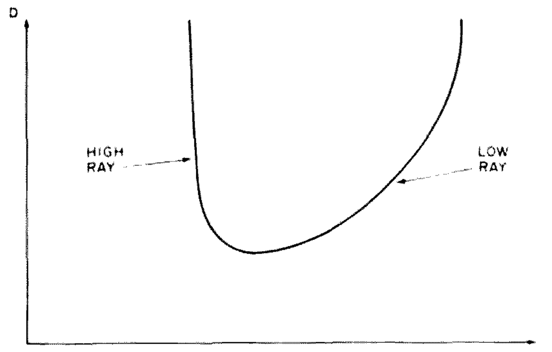

Fig. 3. Variation in skip distance D with vertical radiation angle Ø. Note how critically dependent the skip distance is upon small changes in angle for the high ray. (2)

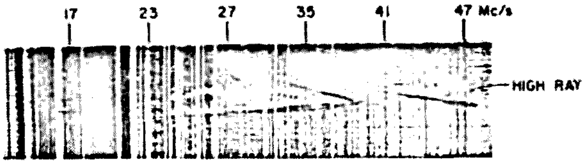

Fig. 4. Ottawa, Slough ionogram for November 14, 1957 at 1556 UT. Note that above 39 MHz only reflection of the high angle ray occurs. (2) (By permission of the Chief Superintendent DRTE.)

sus frequency, for, in this case, an Ottawa to Slough, England path. The horizontal lines show the high and low rays as reflected by a pulsed signal. The "omigosh" data here is that above 39 MHz, reflection occurred *only* with the high angle ray; low angle reflection was simply nonexistant!

A few more easily talked about reasons for the "best" angle to vary involve the great number of possible paths that a ray may "use" when skip distances are great. Fig. 5 illustrates two cases that could prevail along a DX path, although any combination of these hops are possible. Sporadic E clouds enjoy floating around, particularly during the summer months, and may enhance or belittle a band opening if one is hit. Since they are relatively small, a difference in take-off angle may result in a miss by one station, a hit by another, constituting different paths travelled, and ultimately differing signal strengths at the DX end. A similar situation may exist for the more stable E and F1 layers as well. Also, as suggested in Fig. 3, the number of possible paths decreases as the operating frequency approaches the MUF. The NBS tests were started in the spring, with the daytime MUF much above the operating frequency at that phase of the sunspot cycle, so many combinations of paths were possible. Many were apparently high angled paths. As summer approached, the daytime MUF was nearer 20

MHz, and consequently less paths available; the last path to go (at the exact MUF) apparently is characteristically low angled, hence the better results with low angles in the summer. Finally, the ionosphere is full of simple flaws, such as "thin" and "thick" spots, holes, and tilts, all of which play important roles in determining which path a signal may take, and all of which in some way are connected with the incident signal's vertical takeoff angle. What I'm trying to say is that there apparently is no year-round "best" angle, and for consistent results, it would be nice to be able to change the antenna's radiation angle quickly and accurately.

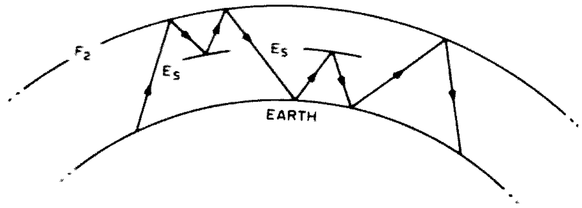

Fig. 5. Possible ray paths for typical F_2 propagation. Any combination of these F and E-layer bounces may occur.

Three methods and results

Accomplishing this accurate radiation angle change is not as hard or expensive as might be guessed; many DXers have undoubtedly tried the suggestions I'm about to present and have, hopefully, met with some degree of success. I'll concern myself with horizontally polarized antennas only, since they are not as greatly subject to ground losses that vary from place to place, and since they are more highly regarded in DX circles.

The vertical radiation pattern of anyone's antenna is, of course, a point by point multiplication of antenna's free space pattern and the ground reflection pattern. The free space pattern is dependent upon the antenna's ability to focus the signal; the lobes or plots of transmitted intensity from such an antenna will lie at an angle of zero degrees with the horizontal. Ground reflection patterns of any horizontal antenna are basically a function of antenna height above a perfect ground. These two patterns, plus a small compensation factor for those of us without a perfect ground, as well as considerations for trees, buildings, wires, or other obstructions, make up the real radiation pattern. Fig. 6 shows a simple example of this three step process.

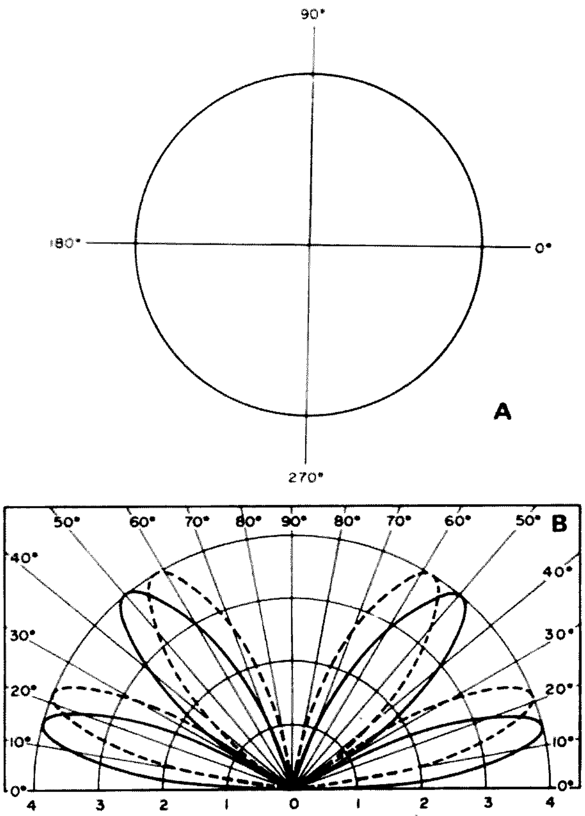

Fig. 6. Example of real radiation pattern determination. Fig. 6A is the vertical pattern of a half-wave dipole in free space for a plane perpendicular to the wire axis. Fig. 6B is the vertical ground reflection pattern in all directions for such an antenna at a height λ above a perfect ground. At the same time, 6B is the ideal resultant when A and the ground reflection pattern are multiplied together point by point for a plane perpendicular to the wire. The dotted line represents a possible final result taking into account obstructions and a less than perfect ground. (3)

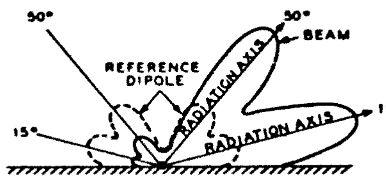

Fig. 7. Overlayed patterns of a reference dipole and a three element parasitic array, both at a height of one wavelength. Vertical lobes of both remain at same angle of elevation and depend only upon height above ground. (4)

The Armstrong method

Antennas with parasitic elements are little different in these respects, as shown in **Fig. 7**. Probably the simplest method of radiation manipulation, then, would involve changing the multiplicative ground reflection pattern. Since for horizontally polarized antennas, the ground reflection pattern is a function only of height above ground, this is easily accomplished by varying the antenna's height. **Fig. 8** shows graphically this relationship for antennas over flat terrain. Note how

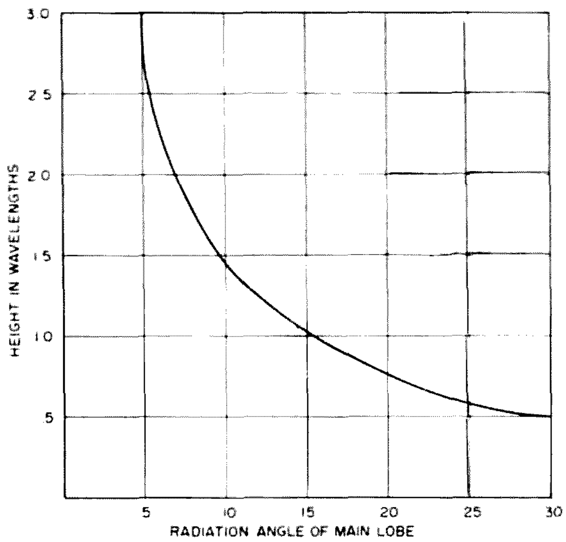

Fig. 8. Relationship between main radiation lobe elevation and height above ground for horizontal antennas above flat terrain. Note how difficult takeoff angles of less than 5 degrees are to achieve in such a situation.

difficult it is to achieve take-off angles of less than 5°. Fortunately, the severe requirements of this graph can be lessened if the antenna foreground is sloping. The math becomes a little embarrassing, but your actual radiation angle can be calculated in such a situation. A more complete analysis is given in "Radio Transmission in the Lower Atmosphere" by Bailey, Bateman, and Kirby, *PIRE*, October, 1955.

Lowering or raising the antenna is then a distinct possibility and although frequently practiced, it's usually agonizingly slow, and hard on arms and winches. It can be helpful, however, for short operating periods, such as contests or DXpedition chasing, when the lowering or raising need only be done once or twice per day.

Stacking

A much better method involves vertical stacking. While not going into the rigors of stacking dimensions, (A very good analysis can be found in "Optimum Stacking Spacings in Antenna Arrays" by H. W. Kasper, K2GAL, *QST*, April, 1958.) I will say that for best results, the antennas should be stacked for maximum gain, with the bottom bay at least $\lambda/2$ off the ground, more if there are numerous obstructions. For three element yagis, this involves spacing of at least 3/4 λ, a troublesome distance for 14 MHz, but a distinct possibility on 21 and 28 MHz. Aside from the three db maximum attainable gain if done correctly, this stacking sharpens the vertical lobes, although the antenna's actual height is now at the midpoint between antennas.

Interesting results can be achieved if an antenna switch is employed to change between any of the three possible antennas which are now present – top bay, bottom bay, and both bays, each with differing radiation angles. This type of arrangement is employed at a local station, K9CSW. Here two three element duoband quads are stacked vertically, with the top bay at 77 feet, and bottom bay at 37 feet, slightly less than optimum for 20 meters, but decent on fifteen. Results have been somewhat encouraging, and appear to bear out the critical dependency on radiation angle that was hoped for. The bottom bay has no doubt made such a poor showing due to its close proximity to ground, surrounding it by the usual city clutter of wires and buildings. In addition, differences in excess of two S-units were noted between antennas during short skip (Sporadic E) conditions. This difference was in favor of a high angle over a low.

Sneaky stacking

A final method involves feeding the stacked antennas slightly out of phase with each other, thus raising the main radiation lobe. The advantage here is that the 3 db that may have been gained by stacking is always present, as was not the case in switching the antennas themselves. Fig. 9 is a theoretical example. For two stacked arrays, A and B, 3/4 λ or 270 electrical degrees apart, best results are achieved when both antennas "look" electrically identical and are fed exactly in phase, with precisely cut equal feedlines. This gives a low main vertical lobe; for simplicity's sake, we'll call it zero degrees to the horizontal. To raise this main lobe, the signal must reach antenna B before antenna A. For a rise of 10°, as illustrated, this required the feedline to antenna A to be longer than that to B by a distance D. Using simple trigonometry, dis-

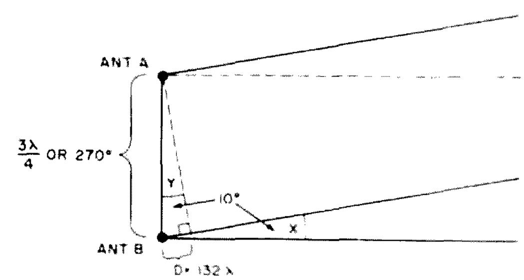

Fig. 9. To raise the main vertical radiation lobe in a vertical stacking situation, antenna A must differ in feedline from antenna B by a length D. Length D depends upon the desired angle x: here we used **10 degrees.** Angle y is also 10 degrees; therefore D is equal to tangent 10 degrees times the stacking spacing, or .132λ. (See Fig. 10)

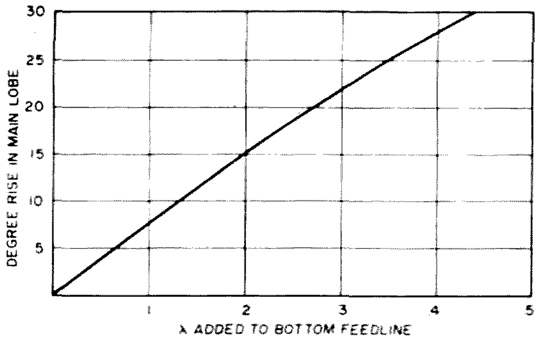

Fig. 10. Graph of wavelengths of feedline to be added to the top antenna in a stacking situation (Fig. 9) for raising the main vertical radiation lobe up to 30 degrees. This will only work for 3λ/4 stacking spacing.

tance D is found to be .132λ. To simplify things, this feedline difference has been plotted in **Fig. 10**. Note that this is only for a stacking spacing of 3/4λ.

A similar arrangement is being tried at K9CSW, with calculated switch positions of 10, 15, and 20 degrees, but results are a little hazy. Possibly the lobes are simply too broad to make a noticeable difference when shifted only a few degrees. Quads are partially stacked antennas themselves, so elevating the main vertical lobe any appreciable amount adds importance to usually insignificant side lobes. It's also quite difficult to keep two quads looking electrically identical for very long. One distinct advantage was noted here, however, over simply switching antennas. Some types of "city noise" apparently arrive at very distinct angles; manipulating the lobes in this manner often resulted in noise reduction on the order of two S-units. In some locations, this may be more valuable than any outgoing signal strength additions.

Conclusion – suggestions and more problems

The question I've still left partially unanswered is exactly what are the best angles? Bill Orr's *Beam Antenna Book* lists the range of optimum angle of radiation as in Table III. This is apparently inconsistent with those findings by Utlaut, (see **Fig. 1**) who found the very best angle to be the lowest tried, .7 degrees, much lower than the supposed 7 degree minimum. This was in light of the fact that the transmitting antennas in this case utilized realitively high angles (12 or 16 degrees) for main lobes. Although only listed for four months, Utlaut's signal strength versus time averages do show definite seasonal variations; low angles did seem valuable during a summer month (June or July) when the rule seemed the lower the better for the time the band was open. The spring months, however, pointed out the advantages in ability to vary the radiation angle, since higher angles dominated for much of the "band open" time. Results at K9CSW have varied, but seem to agree with this trend. Certainly an accurate yearly pattern could be worked out for a particular DX path, but the effects of other phenomena (sunspot number change, ionospheric storms, north-south tilts, etc.) that may be encountered along the variety of paths a DXer is interested in would make the game quite involved.

Band	Range of Optimum Angle of Radiation	"Optimum" Antenna Height
7 mc	12° – 40°	Above 45'
14 mc	10° – 25°	Above 40'
21 mc	7° – 20°	Above 38'
28 mc	5° – 14°	Above 34'

Table III. Geometrically determined "optimum" radiation angles for the ham bands. (4)

Another problem was encountered at K9CSW. Although signal strength differences were sometimes reported in excess of two S-units for one angle over another, it was rare when a same difference was noted on received signal strength. Apparently many DX paths are not completely reciprocal. This is a good thing or we might have to worry about accurately matching the DX station's vertical radiation pattern, but adds to the confusion when trying to decide which angle to use to be heard the best. Even in cases when signals received on both ends were enhanced, the difference was usually not detectible unless two-way key down S-meter tests were run. In contests or chasing a DXpedition, these key down tests are a little hard to come by; the need for some sort of system is apparent. Since accurate angle of arrival measurements are expensively complicated, perhaps only trial and error can devise such a system. It's hoped, however, that such a system actually exists, for it could pay off in great dividends for the serious operator, greatly adding to the effectiveness of even a modest antenna.

. . . K9YOE

References: 1. Davies, Kenneth. *Ionospheric Radio Propagation*, (Washington, D.C. U.S. Government Printing Office, 1965), Ch. 4. 2. Utlaut, W.F. "Effect of Antenna Radiation Angle Upon HF Radio Signals Propagated Over Long Distances," *Journal of Research of the NBS–Section D. Radio Propagation*, (Volume 65D, March-April 1961), 167-174. 3. The American Radio Relay League. *The ARRL Antenna Book*, (West Hartford, Connecticut: ARRL 1956) Ch. 2. 4. Orr, William I. *Beam Antenna Handbook*, (Wilton, Connecticut; Radio Publications, Inc., 1955) Ch's. 1 & 6.

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FSK Exciter

A couple of years of chasing out of tolerance ARC-5's used as vfo's ruled out that approach. And anyone who has tried building a vfo in the 3 to 7 MHz range will testify that obtaining a stability of 20 to 50 Hz is not the easiest of chores.

Some thought was given to shifting a vfo off frequency during standby, and this approach is very workable.

A better idea, however, was to borrow the basic concept from the Northern FSK keyer, which uses a 200 kHz oscillator beating against a crystal in a balanced modulator.

One item (available on surplus) which seemed ideally suited to the job at hand was the sub-assembly O-17-ART-13A.

This is a low frequency pto covering the range of 200 kHz to 600 kHz in three bands and is used in the AN-ART-13. The unit uses a 1625 tube, has a very fine, slow tuning dial, and is extremely stable.

(Note: If this pto cannot be obtained, don't throw out the idea. A 400 to 600 kHz vfo is not difficult to construct around a standard 455 kHz bfo coil, and stability relatively easy to obtain at this frequency.)

Since the pto would be the "variable" portion of the frequency control it seemed desirable to use it without modification. This could be done by shifting the crystal. It would minimize the unwanted frequencies if the exciter output were one half the transmitter output frequency.

Actual construction is straightforward and nothing is critical. Most parts may be freely substituted within a reasonably wide tolerance. The work and testing may be divided into four stages.

1. The power supply may be any 200 – 400 v source. 12 v is necessary for the heater of the 1625. The other tubes may be either 6 or 12 v types, depending on the supply. A VR150 and a VR105 or equiva-

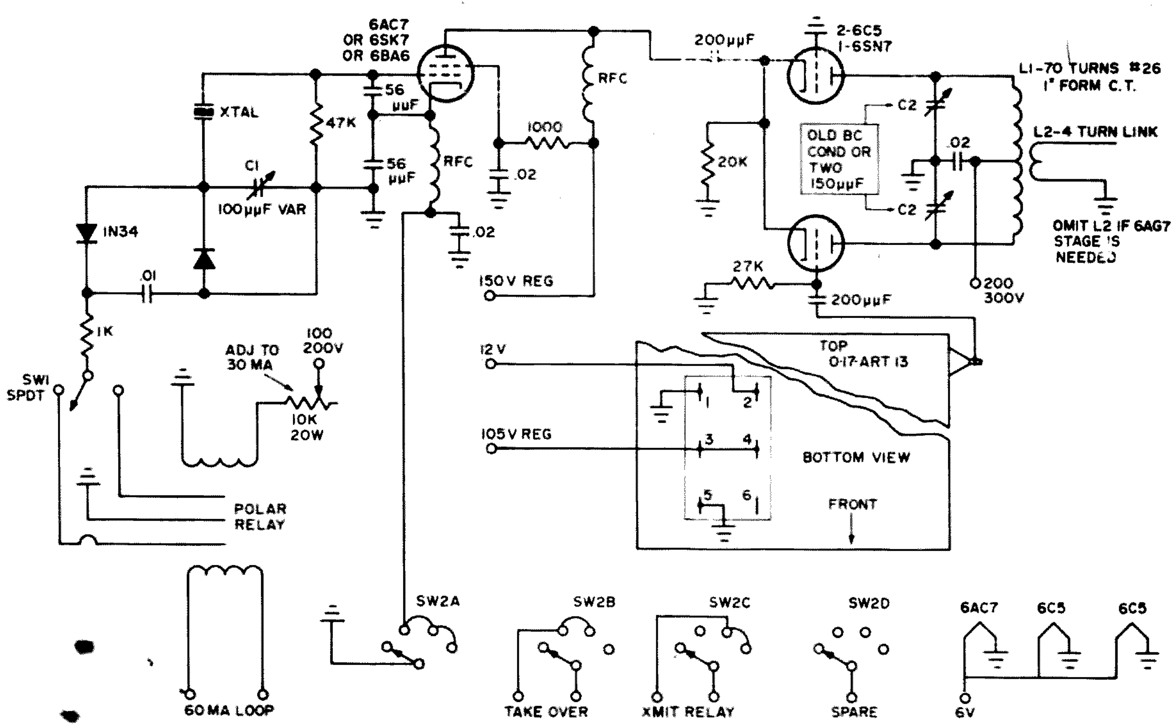
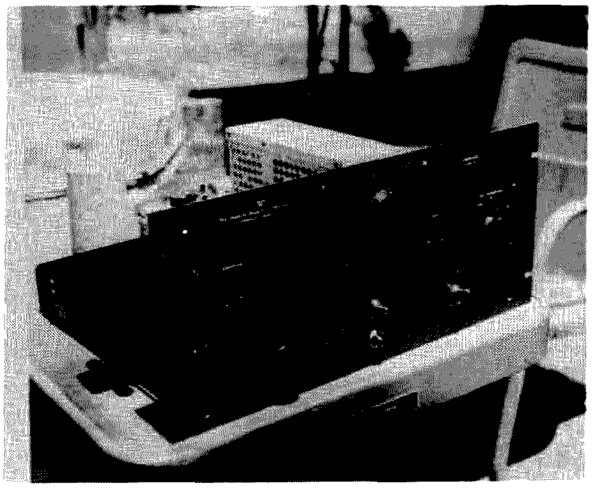


Fig. 1. FSK Exciter Schematic.



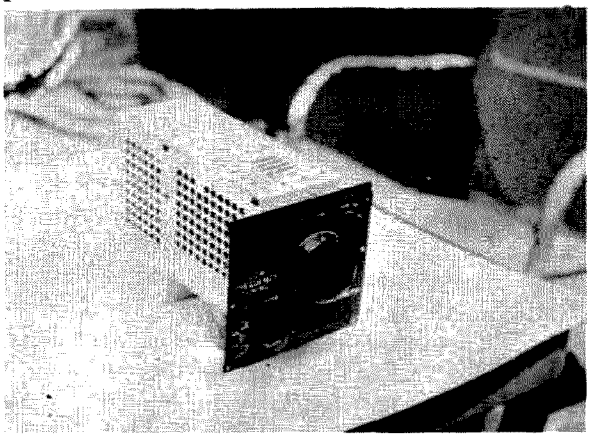
Complete exciter with pto.

lent regulator tubes should be used with the required dropping resistor (value depending on voltage). The O17-ART13 pto should not be used with more than 105 volts to minimize harmonic output. Once the power supply is assembled, the pto should be connected and checked by listening for its signal on the low end of the BC band.

2. Next the crystal oscillator should be completed. The only critical parts are the feed back capacitors from cathode to ground and from cathode to grid. The operation of the shift control may be checked by shorting across capacitor C1 with a screwdriver.

3. The two-triode balanced modulator requires no push pull input of any kind. The tuned circuit L1-C2 tunes the output range desired. Two separate condensers can be used for the sections of C2 if frequent frequency changes are not anticipated.

4. A polar relay is included in the keying circuit. With 30 mA bias current supplied from the exciter power supply, all that is necessary for operation is to plug into the local loop circuit. A turn over switch is provided.



The 0-17-ART-13 pto, available from Fair Radio for $4.00.

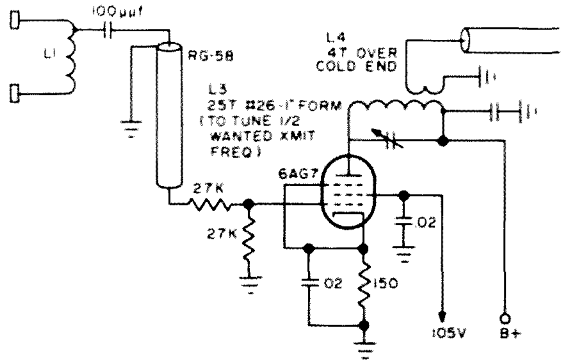


Fig. 2. 6AG7 Amplifier.

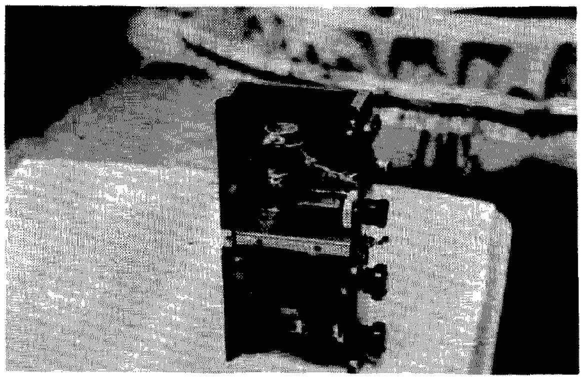


Fig. 2. 6AG7 Amplifier.

The function switch allows complete station control with one knob. In standby position the cathode of the crystal oscillator is lifted from the ground. In the take-over, spot, position the exciter is switched on by SW2-A while SW2-B shorts out the loop across the TU output. This prevents the receiver from keying the transmitter (if printer and keyboard are in series), and also allows a quick return of the printer to lower case by flipping the take over switch and punching the letters key. In the third position the "C" section of SW2 is used to control a transmit relay. In position No. 4 the short across the converter output is removed and the transmitter may be keyed by an incoming signal.

As with any hetrodyne circuit, care must be exercised not to tune up on a harmonic or wrong beat. The unit should be set up initially with a grid dip meter or absorption wave meter. The crystal used must be chosen so that the fourth or fifth harmonic of the pto does not fall on or near the wanted frequency.

By doubling in the transmitter any unwanted is further removed from the tuned output of the transmitter.

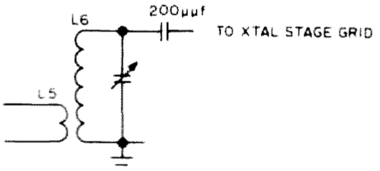


Fig. 3. Coupling coil to transmitter.

The average RTTY enthusist will devote long hours and careful planning to come up with the best possible TU. Then in a rush to get the rig on the air will, all too often, slap a diode shifter on any existing VFO – with less than the desired result.

Or, should he decide to shift a crystal he may spend hours grinding the rock to a net frequency only to find his shift shy of the 850 Hz. Not to mention the fact that the net frequency may change about the time he finally gets within tolerance.

In fact it was grinding my fifth crystal for Air Force Mars net operation in a little over one year that made me decide to do something, even if it were wrong.

Some Transmitters may require more drive than that obtainable from the balanced modulator. An amplifier stage becomes necessary. A 6AG7 is a logical choice. The grid of this tube is capacitively coupled to one side of coil L-1 through a short length of RG-58. Two or three turns should be removed from this side of L-1 to maintain balance. (If individual condensers are used for C-1, this may be maintained by tuning.)

The layout of the 6AG7 stage must be made with care. Some physical separation is desirable between the coil L-1, and the 6AG7 tube socket. The output coil, L-2, must be placed above chassis, (If L-1 is below) with the plate lead going directly topside from the tube pin. The 27,000 ohm resistor insures complete stability.

Low impedance output, either from the balanced modulator, or the 6AG7 stage, if necessary, allows the exciter to be located a convenient distance from the transmitter.

A tuned link coupled input coil should be used at the crystal stage of the transmitter.

Of the three FSK keyer units I have built, all have proved a pleasure to use. It has been found unnecessary to let the pto run all the time, as it will be well within tolerance from a cold start. And a five minute warm up will put you right on the button. The shifters have been used days at a time without touching the dial on Air Force Mars circuits.

So if you are having problems with drift, setting up and maintaining proper shift, or if you are simply tired of grinding rocks, the O-17-ART 13 pto shifter may be your answer. . . . W4LLR

The First QSL

Probably it was reading the ARRL quotation, "A QSL is the final courtesy of a QSO," which prompted me to dig into several hundred old QSL's in order to find out when and who started the "bloody mess." Unlike the story of the "Chicken and the Egg," there is no doubt that ham radio came first and that the art of QSL'ing was not far behind.

Apparently it started around the middle or the end of 1921. I was operating 1IV at Bridgeport, Connecticut, at that time and my first card came from E. Laufer, 2AQP, who reports hearing my signals on October 9, 1921, using a one tube regenerative receiver. This was followed by a QSL from J. E. Hodge, 4BY, dated November 10, 1921, and a report from Gerald H. Edison, 1BMY, December 30, 1921, asks, "What is your radiation current?" These QSL's are all written on penny postcards with the call letters put on with a rubber stamp or crayon. The first professional print job came to me from 2BRB (now W2BRB) and included a picture of the station. It is dated December 28, 1921, and most certainly Ed should be considered to be among the first of the QSL'ers.

By 1922 and 1923 the QSL business was booming. Fancy printed cards were replacing the home-made ones with everyone trying to outdo the other in splendor.

1923 brought the first of the DX cards. My first is from W. R. Burne, British 2KW, who received my signals on two valves, September 5, 1923, at 04.10 GMT; so to the British go the credit for being the first to use GMT on their QSL's, but no doubt their geographical location had something to do with this.

Just in case you think the "big boys" of that era were too sophisticated to QSL, you are wrong. I have a QSL from 1AW, signed by Hiram Percy Maxim; one from S. Kruse, 10A and 9ZN, R.H.G. Mathews. Others include John Reinhartz, 1QP; Irving Vermilya, 1ZE; Dr. Cyriax, 2DI; and, Leon Deloy, French 8AB. Even the famous 1BCG confirmed a QSO with me on July 29, 1923. 2BO—still going strong as W2BO sent me a card dated May 10, 1923, and says he is running 20 watts and using a paragon receiver.

I suppose we will never know who sent the first QSL card but we can pin-point the year as 1921 and what a lot of QSL's have been exchanged in those forty-seven years.

C. Harold Campbell, W2IP

Telephone Beeper

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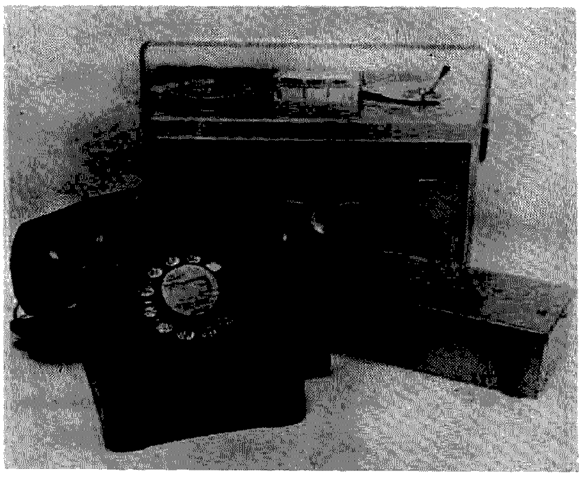
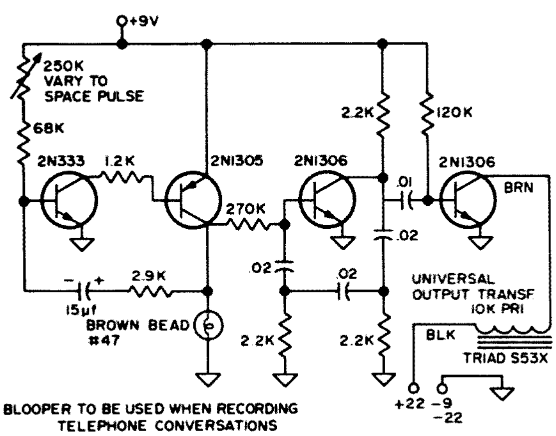


The following is a description of a telephone "beeper" to be used when recording telephone conversations. The "beep" can be adjusted to beep every nine seconds as required by the Public Utilities Commission.

Without going into the legality of the device, let's say it can be used to insert a beep into the telephone conversation that is being recorded, by inductively coupling into the telephone coil. The use of the device is visualized when recording phone patch traffic or recording a telephone message to be transmitted at some later time.

Theory

A 2N333 and 2N1305 transistor forms a multivibrator whose time of beep between pulses can be adjusted by a 250K potentiometer. The pulse stays on for one half second, allowing it to drive a 1 kHz oscillator much better than a saw tooth or unijunction type will drive it. When the pulse is too narrow the tone is not clear, thus experimentally the multivibrator was used.



Beeper to be used when recording telephone conversations.

A brown bead No. 47 lamp bulb acts as the pilot light and also as a non-linear element which helps to sustain reliable pulsing periods. The multivibrator drives a feedback type oscillator using a 2N1306 as the oscillator. This oscillator signal is amplified by a 2N1306 to create enough current through a coil to generate enough of a field to couple into the telephone instrument coil.

Construction

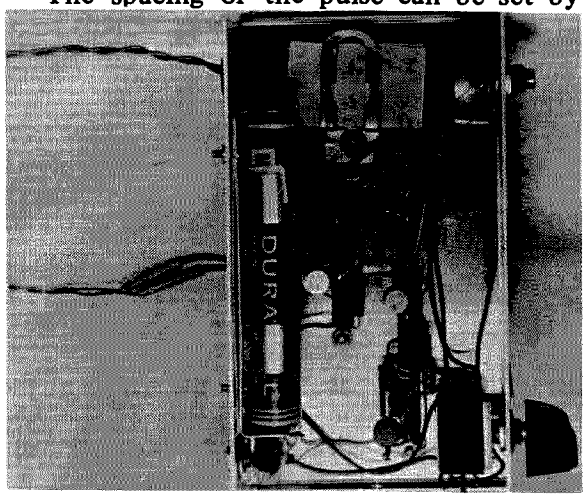
The "beeper" is built into an LMB type box, 3-1/2" wide, 2" high and 6" long. For simplicity the parts are mounted on terminal strips rather than on a printed circuit board.

Power is supplied from a 9 volt mercury type battery for long life, although, any 9 volt battery should last a very long time. The amplifier's source is 22 volts, which creates more current through the coupling coil.

Many types of coupling coils were tried, but an S53X output transformer seemed to work the best. The case was pried off and then the keeper or end of the core was driven off, using a hammer and screw driver. It was thought a stronger field could be obtained by sawing off one of the sides of the transformer to concentrate the field between the center and one outside core, but there was no difference in the coupled signal and it was not worth the effort.

There are no special precautions in wiring the unit except to get the polarity of the 15 mF condenser in the multivibrator circuit correct. If it is backwards, the oscillator will not work. An indication that the circuit is functioning can be determined by watching the lamp blink.

The spacing of the pulse can be set by



Note the battery mounting and parts installed on terminals.

turning the 250K poteniometer and timing it with a watch. A pair of crystal earphones can be clipped across the coil if it is desired to hear the tone, or the tone by induction into the telephone is another way to listen. The telephone coil is generally on the right side of the telephone as shown in the photograph. The transformer can be moved back and forth over the side of the phone until a maximum coupling is noticed and the transformer taped into place.

The circuit probably has other uses and comments might be suggested, but for our purpose it has served for inserting a beep into the telephone for recording. ...W6BLZ

(Continued from page 2)
of the bulging counters full of 19¢ pots, 5¢ tubes (guaranteed to light, play), and 29¢ tuning condensers.

Sideband came next and finished off the old surplus gear that was still working and most of the active amateurs made the move up to a transceiver...commercially made. Lordy, it would take a lab of test equipment to get one of those things working if you *could* build it. Even the servicing problems were getting beyond most of us by this time. How many fellows are going to go out and buy an oscilloscope and the other choice test gear needed to keep the modern transceiver working smoothly if they are going to use it only for an occasional service job? Virtually none, that's who.

This leaves us in the lousy position of not building our own equipment and not even being able to service it. Ham radio has come a long way. The old timers lament for the good old days, but no matter how loud their laments, they are buying just like the rest of us. Can anything be done about it? I don't know! Does anything have to be done? Has amateur radio changed so much that it is no longer worth keeping going?

What *are* the requirements for keeping amateur radio alive in our country? Let's take a look at the FCC regulations and see how we stack up these days as far as the purposes of the amateur radio "service" are concerned.

SUBPART A—GENERAL

97.1 Basis and purpose.

The rules and regulations in this part are designed to provide an amateur radio service having a fundamental purpose as expressed in the following principles:

(a) Recognition and enhancement of the value of the amateur service to the public as a voluntary non-commercial communication service, particularly with respect to providing emergency communications.

(b) Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.

(c) Encouragement and improvement of the amateur radio service through rules which provide for advancing skills in both the communication and technical phases of the art.

(d) Expansion of the existing reservoir within the amateur radio service of trained operators, technicians, and electronics experts.

(e) Continuation and extension of the amateur's unique ability to enhance international good will.

The first, and presumably most important, function is (a) to provide emergency communications. I think we can do this all okay. There's nothing about building there.. For that matter, our commercial transceivers are vastly superior to home made equipment on several counts...easier to use...less down time ...anyone can use it...compact, etc. Old timers will tell you stories about the olden Field Days when fellows tried to tune and use someone else's rig and the troubles they had. My six-foot rack has been replaced by two small desk top boxes. And with about one amateur for every 800 people in the country we can provide emergency communications just about anywhere anytime. I think we should get a good high mark on (a).

Considering (b), it is difficult, of course, for even the above average amateur to try to compete with the well financed research laboratory for most development work. We can still compete with them when it comes to major break-throughs. Labs cannot possibly afford to spend a lot of money on something that does not have virtually a 100% chance of succeeding. We can. Fellows like Frank Jones, Bill Hoisington, Sam Harris, Bill Ashby and many others are doing work that is invaluable to our society...work that few labs would ever support. It is too bad that there are so few really outstanding men like this, but then, even in the past, there were only a small handful that made real contributions. I suspect that amateur radio is as valuable as it ever was in this respect.

(c) is very interesting. Verrry. Obviously, our incentive licensing rule changes reflect this aspect of the purposes of amateur radio. But have our rules really kept up with the technical end of things? Let us take another look back into our past at this time.

The first amateurs used the Morse Code for communications. It was considered difficult, at best, to modulate a spark transmitter, so code was the answer. Then came CW and the invention of the modulator, giving us AM. In

the 20's and 30's the phone transmitters were considerably more expensive than CW rigs and a lot more difficult to tune, with the result that most amateur operation was via CW. But, as soon as phone was available the hams started using it and the percentage of phone ops grew steadily. Most operators preferred to talk rather than whistle and they changed to phone as soon as they could afford it.

Sideband completely broke the back of the CW holdouts. Their complaints that CW could get through better than phone or that a CW rig was much less expensive than a phone rig fell apart. Sideband, they found, could get through just about any time that CW could! And the Heath $99 SSB transceiver forever stilled complaints about cost.

There are still a sizable number of ops that use CW because they enjoy using it, but few, except Novices, use CW out of necessity. With the percentage of CW operation dropping year by year, many have wondered just why the FCC added the 20 wpm requirement to the Extra Class license.

Modern communications techniques would seem to put emphasis on things like RTTY, facsimile, slow scan television, narrow band television, time sharing of channels, and other developments rather than harking back to our early days and our most primative mode. The FCC, to the contrary, has been decidedly backwards in handing down favorable rules for RTTY, facsimile, television, etc. Amateur development of these modes has been harassed and impeded by the FCC rather than helped, as per (c).

Part (d) calls for trained operators, technicians and electronic experts. We are concentrating more on trained operators these days than technicians. But, with some 10,000 of us active on the VHF's and a similar number working with RTTY and other advanced modes of communications, we are not doing too badly in the expert department.

Good will? With phone contacts as simple as they are today tens of thousands of DX operators can talk and make friends with fellows all over the world. A few simpletons yelling break-break, or calling doggedly on a DX frequency can create ill will, but for the most part, ham radio is a friendly world community. A recent report of the Stanford Research organization showed that, dollar for dollar, radio amateurs achieve more good will than short wave broadcasting...by a large margin.

We might try to curb our penchant for donating money to DXpeditions too. These often bring terrible ill will for us from abroad. The big problem is this: since the DXer is doing the job for money, he is very apt to by-pass a lot of formalities and tread heavily on toes in order to get on the air. One DXer went into Jordan a few years back and went on the air without a proper license. The result was that ham radio was finished there from then on.

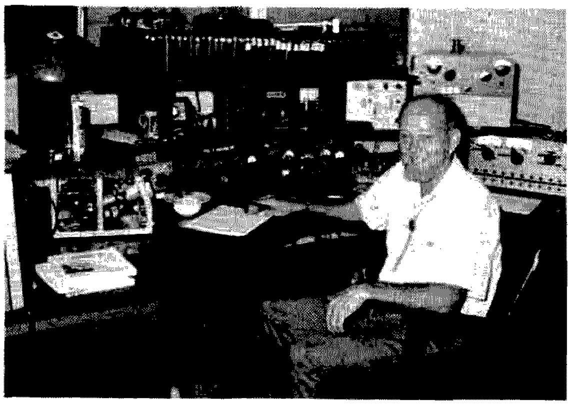
All in all, when you look over the FCC basis and purpose for amateur radio, we seem to still, in spite of all the changes that have come about, be well worth our salt. Perhaps those that are calling for a return to building should take a look at the balance sheet.

My own feeling is that building equipment is a lot of fun and I intend to run every construction project in 73 that I can get my hands on. Of course, I will tend towards pushing the newer modes such as TV, RTTY, SSTV, FAX, FM, and the like. We have a thousand or so hams that spend their hobby hours building equipment. Few of them ever get on the air for more than a short test of a new unit...then the parts go back into the junk box and the next project is underway. These are the fellows who provide us with most of the original constructions articles... this is why you keep seeing the same calls over and over in 73.

It is important for us to do everything we can to see that we constantly have new amateurs entering the hobby. A certain percentage of these newcomers will turn out to be builders...others will go for new modes...and a very few will get some sort of weird idea for a radical change and spend years working on it...and they just might succeed. I am reasonably sure that it won't be long until someone makes a gigantic breakthrough into another form of communications which will make radio obsolete. It could well be one of the Novices who will get his ticket this fall.

What do *you* think? ...Wayne

Recent Visits



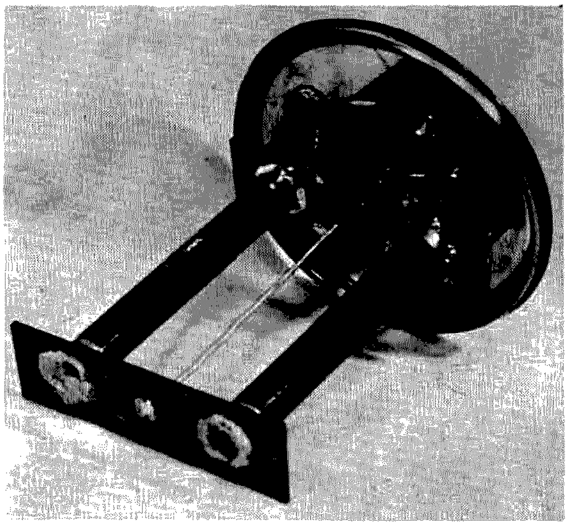
Sam Harris, W1FZJ/KP4 runs the receivers down at the world's largest dish in Arecibo. Sam is active on 75M in particular, working DX along the low end of the band. He is also working on a miniature Arecibo dish at home, a few miles from the Big One. His 75M and 40M antennas are hanging from the three "haystack" mountains that surround his QTH.

Helen Harris, W1HOY/KP4 keeps her ear fastened to the receiver on six meters all day every day. She doesn't miss an opening if she can help it. If you're on six you've probably worked her by now. Helen has an incredible card index file of the thousands of stations she has worked on six meters so far. Note the 50 or so notebooks over the operating position!

Dick Spenceley, KV4AA is alive and well on St. Thomas. Dick is another who got off the DXCC treadmill when crossed up by Miller. He still keeps at it, but for fun now instead of blood. Does Dick have the world's best fist? Many think so.

...Wayne

A Kilowatt Dummy Antenna . . . Cheap!

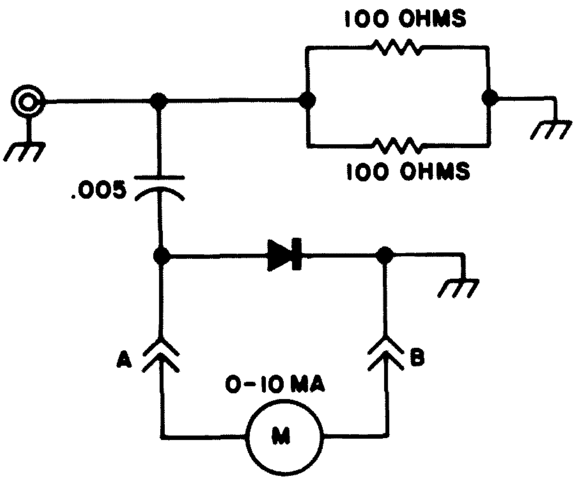


Allan H. Matthews, WB2PTU
R. D. #1
Waverly, New York 14892

This article describes a dummy antenna capable of handling one kilowatt, to be built at a cost of under \$4.00. In my case it cost \$1.53, but that was with a junkbox.

In a back issue of 73 (where else?), there were some 100 ohm, non-inductive resistors advertised by Mendelson Electronics, 516 Linden Ave., Dayton, Ohio. I ordered two of these at 50¢ each for my dummy load. When they arrived, they were 3/4 inch in diameter and 6 inches long, with both ends tin plated. I do not know the power rating of these resistors but they are more than adequate for our use. This unit will handle over 100 watts PEP with *no oil.*

The photograph tells the story. The top and bottom plates were cut to dimension, punched and drilled first. Next the resistors are fitted into the outside holes of these plates and soldered into place. I used 1/8th" double copper clad glass epoxy board and soldered the resistors to both sides of the board. Next run a heavy wire down through the center hole of the top plate and into the small hole of the bottom plate. Solder it on both sides of the plate. Center this wire in the top plates center 3/4" hole.



The next step involves a gallon paint can which can be purchased empty and clean at many paint stores for about 50¢. Punch the top of the can for a coax fitting, drill the holes to mount the unit inside the can and if you want a relative power output attachment, drill holes for the feed-thru terminals you will use. Also, drill 1 extra 1/16" hole in the top of the can.

Mount the top plate hanging down from the top of the can on 3/4" metal stand-offs. The resistors will clear the bottom of the can nicely at this height. Now mount your coax connector, your feed-through terminals and the other components in place and solder them. Run a couple of copper braids, (coax shield) from the top plate to the top of the can and solder them well on both ends. They will help to provide a low impedance ground path. The diode I used was of doubtful ancestry, but a 1N34A should do the trick. This relative output meter circuit allows use of a fairly heavy meter, dependent upon the power of the transmitter and the frequency of operation. A variable resistor across the meter will be an aid.

Now go to the power company and scrounge a gallon of transformer oil or fill the can with mineral oil, leaving about 1 and 1/2" of space at the top of the can. *Do not use motor oil!!* The extra 1/16" hole? Oh, that is to relieve pressure as the oil heats up. When not in use, plug it with a match stick or small bolt. Well, there it is, a kilowatt dummy antenna at a price everybody can afford.

...WB2PTU

One that Didn't Work Out

Don't misunderstand me. The home-brew coax switch I'm about to describe works fine. It just cost more than it should have, and it doesn't do quite all that a commercial unit does. If the purpose of home-brewing is to save money while producing gear equal or superior to commercial products, this project qualifies as a failure. Still, it may be of interest.

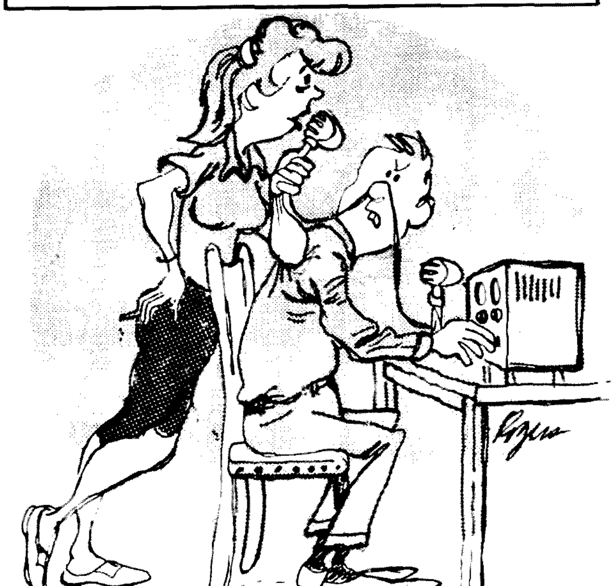
First, you take a cat food can—one of the little ones that contains the so-called "gourmet" cat foods. Open it and feed your cat the contents. (You *do* have a cat, don't you?) Then wash it—wash it *very* well. If you don't you'll have a very smelly coax switch!

Now, mount six SO-239 connectors equally spaced around the outer wall of the can. (Use the single hole mounting type if you can.) Drill a hole exactly in the center of the bottom, mount a six position ceramic switch with 60 degree indexing, and line up the contacts with the sockets. Note that in one position, there will be no connection, since one of the sockets serves as the input to the switch. Wire it up using short lengths of #12 wire. Cut a disc of flashing a little larger than the diameter of the can, and seal up the back by laying a bead of solder between the rim of the can and the flashing.

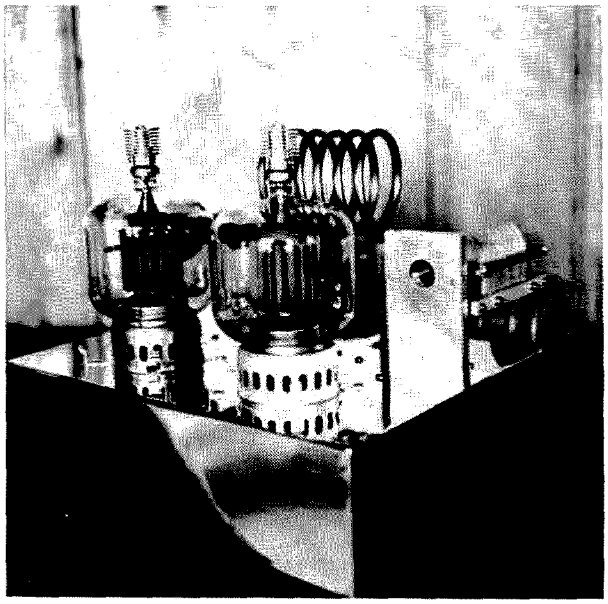
If you buy everything new, the switch will cost you five or six dollars. It doesn't ground the system in the "off" position, and it won't handle a kilowatt. For about five dollars more, you can buy a switch that does. However, crosstalk is low in the home-brew switch, and if you have enough coax connectors and a suitable switch in the junkbox, it may be up your alley. Works fine for switching between antennas, dummy loads, transverters, etc. If your junk box doesn't contain the necessary parts, take my advice—go buy a commercial unit.

There's a moral in this somewhere...something about the point of diminishing returns?

Bob Grenell, W8RHR



"OK, so tomorrow you get your own transceiver!"



Mini—Bomb

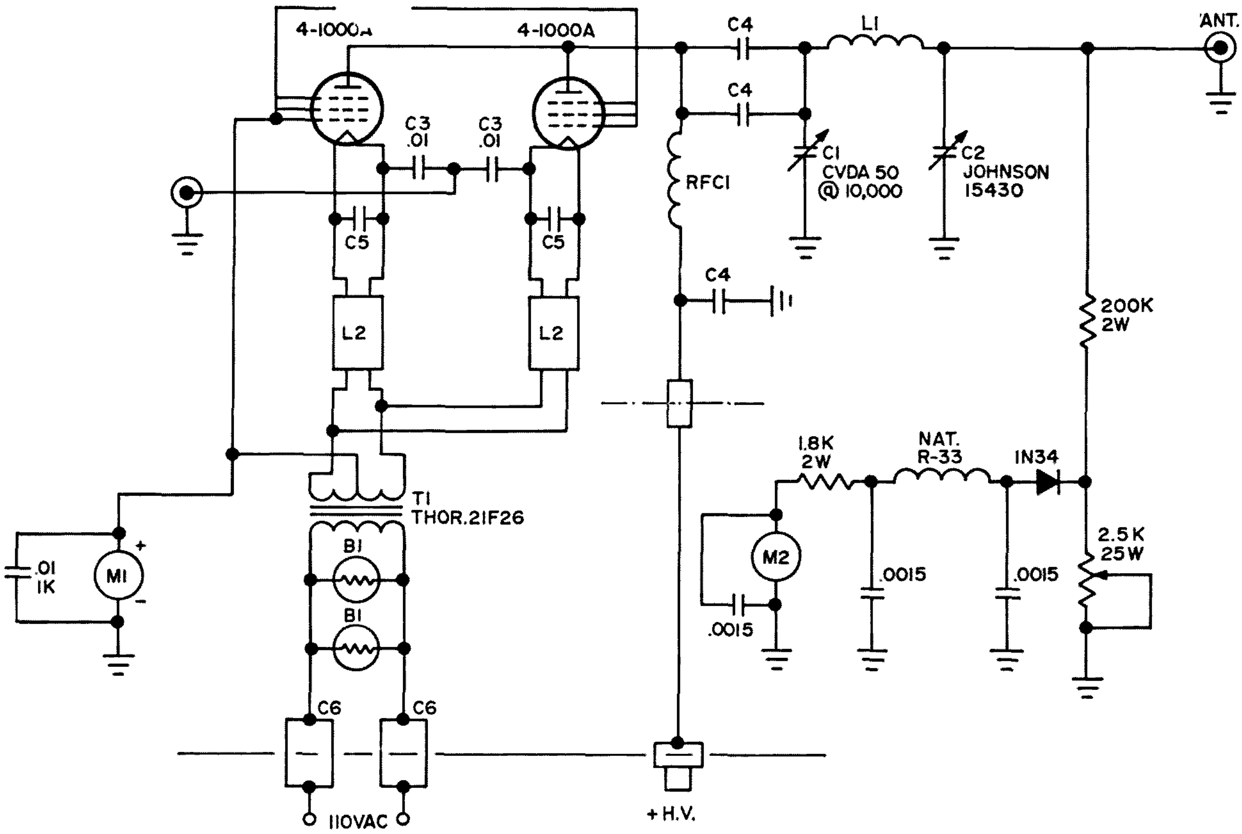
Bill Brown WφSYK
28 Marine Lane
Hazelwood, Mo.

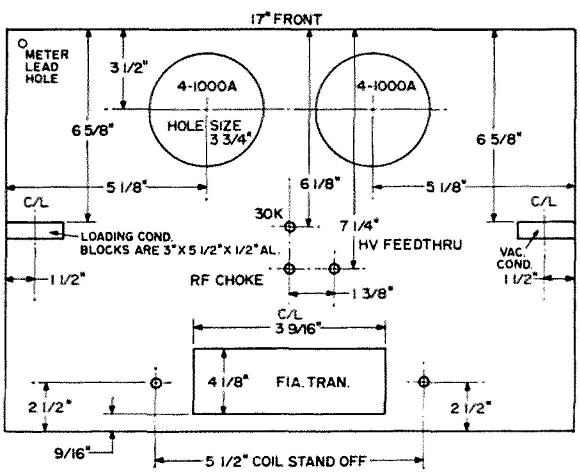
After many attempts to design a two tuber (4-1000A or 8166) on a standard chassis (13 x 17), I gave up in despair and went to a larger chassis which was 15" x 26" x 6" deep. An article was published in the May issue, 1965 called the "Big Bomb". I know of more than 30 Hams that are using this design.

The smaller rig got started one afternoon after finding a very small ceramic vacuum capacitor. After two days on the drawing board I finally got all the parts laid out without overlapping. Some features that might be of interest are as follow: Both plate and loading capacitors were mounted on 3" x 5½" x ½" Machine aluminum blocks, which will prevent current losses and will add to the high efficiency. Checks proved efficiency as high as 72%. I would like to call your attention to the high voltage feed-thru. These are home-made out of 1" round teflon extending 1" on each side of chassis. Breakdown was better than 30 K. Plate coil for 20 meters was formed on quart bottle of TANQUERAY gin (dia. 3⅝"), length was 5½". (Tubing ⅜" used). The design of the "Mini Bomb" is such that parasitic chokes are not necessary, and this final was checked for this with voltage better than 7.5 K. Chassis was chrome plated to prevent rusting and for appearance.

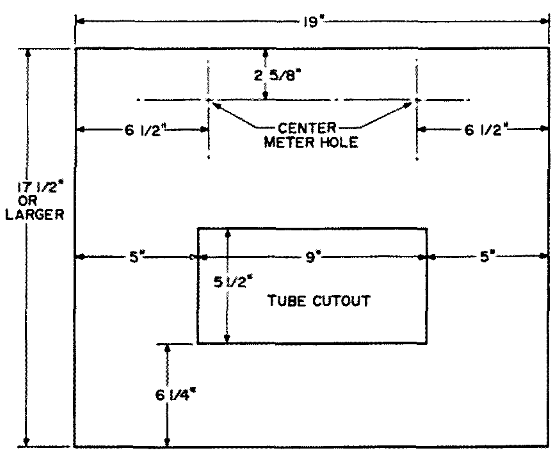
Since the tubes are in the front and centered on the chassis; a 6" x 9" cutout was made to view tubes. This cutout is 6½" from the bottom of the panel, which is steel, and 17½" high. Two meters (3½") were placed above the cutout. The plate meter is 0-1.5 amp. and the output meter is 0-1 mA with a 0-10 *rf* amp. scale being used. The large 3" Groth counter Dials rounds out the Panel.

This final is housed in a 61¼" cabinet with 24" depth, in order to make room for





MINI-BOMB CHASSIS LAYOUT



PANEL LAYOUT, MINI-BOMB

the blowers. The panel below is used for the *"wheel"* which is a Superior 28 amp. powerstat. The bottom panel is used for power supply, ac switches and pilot lights.

Power Supply

A real heavy duty power supply can be built for less than one hundred dollars. The plate transformer was purchased from the local power company for less than 20.00. The rating is 5 KVA @ 7200 volts ac. This will give around 6500 volts dc under load for the highest voltage. I like to operate with a voltage of 3700 using 100 watts drive from a Collins 32S-1. Two 550 mA UTC chokes are used in the negative lead. These chokes are in series with the swinging choke, followed by the smoothing choke. Solid state silicon rectifier were built up by using 48 (1 amp @ 1 K. Diodes) Oil capacitors were purchased from the power company also, at the rating of 2500 AC @ 7.5 mfd. Four units are being used giving a total of 30 mfd better than 7000 VDC at a price $5.00 per unit. A bleeder consisting of seven 10 K @ 200 watts resistors in series finishes the power supply. In closing, I have been using this heavy type of construction for the past 11 years without a single break-down of any part in this rig, Good DX-ing.

. . . WØSYK

DX'ing from DL Land

Joseph D. Burnett, Jr., DL4BR
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APO New York 09009

This is an American's view of what it's like to operate an Amateur Radio station in Europe. This is by no means a unique achievement–many hams who are in the Armed Forces are transferred to Europe each year, but I have never seen an account of their experiences in print. For those who are coming to Europe in the near future, this may serve as a guide of what to expect. For others who will never have the opportunity to sign a "DX" call, I hope this will be interesting.

I received notification of my assignment to Germany in January 1967, with instructions to report during the month of April. Along with finding out all I could about the base to which I would be assigned, I set about trying to determine what would have to be done to set up a ham station. Since all I had read concerning reciprocal licensing stressed contacting the agency responsible for the issuing of licenses in the country to be visited prior to arrival, I wrote to the Bundesministerium in Bonn, requesting information and instructions. I received a reply very quickly (via Air Mail), and the gist of the letter was that I would have to go through the Military Affiliate Radio System, since they serve as a liaison with the German licensing officials (the Deutsche Bundespost). After I arrived in Germany, things were a bit hectic, as in any move, but I managed to get to the MARS station on the base and fill out the necessary forms, and then a helpful clerk made the necessary photocopy of my Stateside license (for proof of license class), and the paperwork was set in motion. Red tape being what it is, it was about a month before I got my license. This cost $9.75 for one year–we get off cheap in the States!

Now to get on the air. I had been busy with moving into an apartment and getting settled, and so far had not erected any antennas. so I strung a twenty meter dipole across the apartment. My first contact was with UW1AC, 5-7-9, both ways. Not too bad for my haywire set-up, but I definitely needed something a bit better. After examining the situation I decided that to keep on good terms with the landlord (who lived immediately below us) and still radiate a signal, I'd have to hang something up in the attic. There are quite a few people in Germany who have large yards with lots of nice trees, but the majority of the people build their houses close to the street and turn the back yard into a garden. The housewives spend a lot of time keeping their houses and yards spotless and beautiful, and the gardens are right out of a picture. Our landlord and his wife were of the majority, and I wasn't sure how they'd react to an ugly pole sticking up out of that picture-book garden, with wires and cables hanging all over the place. So, what with the language barrier and a shortage of apartments I took the easy way out. Looking at it in retrospect, I think that if I'd brought a beam and tower here with me the landlord would have been more than happy to let me put it up, and perhaps even helped me with the installation. I have yet to find anyone who has had problems with a landlord here in Germany, except those who have made a nuisance of themselves with loud parties, etc.

Now, I had antennas for ten, fifteen and twenty meters (or indoor, air-cooled dummy loads, if you prefer), and I started operating. I was a little worried about the language barrier on the ham bands, but I needn't have been. English seems to be an almost universal language among hams. Naturally there are some mistakes in pronunciation or word usage, but the thought gets across, and that's what counts. I stayed in the DX bands at first, since that's where I expected to find hams who spoke English, but after taking a German conversation course I braved 3.5 MHz CW, using a matchbox and a hunk of wire; lo and behold, the same old abbreviations were in use there, and I felt at home almost at once. Unfortunately, too many of the QSO's I've had were of the "Hello, goodbye" type, but there were a number of ragchews both on CW and phone–something you don't have a chance to do very often when you work a DX station from the States.

The regulations governing amateur operation here in Germany are much the same as in the States, except for a reduced maximum power input and some of the frequency allocations. We are allowed only 500 watts dc input to the final: but that's not too bad, because there isn't the QRM level here that there is in the States. However, on eighty and forty the popular Heath single band transceivers are useless without modification (as

are some of the other transceivers). The DX bands are the same as in the States, but forty is only one hundred kilohertz wide, and eighty is three hundred kilohertz wide (7.0-7.1 MHz and 3.5-3.8 MHz). There is no official CW/phone separation of the ham bands here, but by gentlemen's agreement the lower one hundred kilohertz of each band is set aside for CW use; the exception being on forty, where the lower fifty kilohertz is usually CW only, but sometimes this varies with band occupancy.

TVI is not an overwhelming problem here as it occasionally is in the States. For one thing, the TV stations are controlled very closely, and have been set up for optimum coverage, thereby reducing or eliminating "fringe" areas. In my area the channels in use are 12, 14, and 40; and to get a harmonic into one of these, you'd really have to work at it. Fundamental overload is still a problem, but one that can be fairly easily corrected with a little cooperation. Even quiet hours are no great hardship, as the TV doesn't come on until early afternoon, and usually signs off before midnight.

Our AC power is 220 vac, 50 Hz, and it's fairly well regulated. There are transformers available commercially to step this down to 110 vac, and with few exceptions any gear designed for 60 Hz will work all right on 50 Hz without excessive transformer heating. Most of the better American manufacturers are providing export models of all their gear now, so if you're concerned about possible equipment damage this might be something to look into. I work in a test equipment repair and calibration facility, and to date the only problem we've had with transformer burn-out (due to line frequency) has been with some poor quality imitations of Tektronix equipment.

My pet peeve about my tour here has been (and is) QSL's, and the lack of them in my mailbox. I get a card out to each station worked, with one or two exceptions due to lack of address information, but to date, my return rate from W/K stations is just above fifty percent. I'm sorry to say that the return rate from DX stations is somewhat lower, but perhaps they have postal problems I'm not aware of.

This is not a complete picture of the American ham in Europe by any stretch of the imagination, but I hope you found it entertaining. If there are any questions, drop me an SASE, or look for me when the skip is good.

...DL4BR

Katashi Nose, KH6IJ/1
10 Cambridge Street
Belmont, Mass. 02179

On the Use of Phonetics in Pileups

If you are among these fortunate enough to have a call sign like W6AA, you won't be interested in the rest of this article, but if you have one like WD2BJB, you may be interested to know what the DX'er on the other end of a DX contest pileup thinks of you if you say "Whiskey, David, the number two, 'D' as in Denmark, 'J' as in Japan, and 'B' as in Boston."

Some time in the nostalgic past when all call signs began with a "W" or with no prefix at all, it was an easy matter to decipher call signs. Today, with so many prefixes to choose from, we seem to have gone overboard in our phonetic frenzy to get call signs across.

Phonetics are to clarify, not to confuse, yet frequently we are apt to accomplish the opposite by employing certain techniques. In a hot contest or pileup, the object is to get as much information across in a short time as possible. Frequently in a contest, the contact is over while a slow caller is blissfully repeating his phonetics.

There are two things wrong with "Whiskey David, the Number two, Denmark, Japan, Boston." For one thing there are too many bits of information to remember, and secondly, remembering the proper order puts one more burden on the DX station.

Let's put yourself on the receiving end of a pileup. The important part is "DJB," the rest can be filled in at leisure after the contact has been established. What would you do if you were a WB2 and you heard the DX station announce, "The WB2 what was your call?" Immediately all WB2's are compelled to answer. However, "The station with call like DJB" immediately identifies you unless there happens to be a BJD, BGD, BJB, or some other phonetically similar call, a rare coincidence. If you go back in the face of such positive identification, you would be ostracized.

The important thing is to get at least two letters of your suffix across. If the DX station has any savvy at all, he will pry the rest of the information from you at his leisure. When the DX asks for a fill, give him only the information he wants. He asks for a fill because of QRM and not much else.

How effective is "Denmark, Japan, Boston?" After about 3000 contacts, the DX'er is a pretty weary fellow. After hearing "Denmark, Japan, Boston" he is liable to mutter to himself, "Now was that Japan, Boston, Denmark or Boston, Denmark, Japan?" By using phonetics you give him the extra task of trying to remember which word came before which. The order may be trivial to you, since you have practiced it many times, but the DX operator has heard that combination for the first time and he has to remember the order.

Just plain "WD2BJD" is apt to be more effective because it is easier to remember for the DX'er. He might have gotten it as "WB2BGB" but what does it matter? You've nailed him and can now correct him at your leisure. Better still you should say "WD2BJD, Baker John Dog" and *not* the reverse order, WD2 Baker John, Dog, WD2BJD. The worst of course is "William Dog, the number two, Baker, John, Dog." The DX'er now has to remember a Baker, two dogs, a John, a William and a two floating around some place and must place them in proper sequence. No wonder he mutters to himself.

Stick to plain WD2BJD, no phonetics until asked for. If the DX'er goes back to only those who give phonetics, he probably won't be a winner for his country because he is taking too much time per contact.

Going to the other extreme, I have heard something like "DJB, DJB, DJB" given with no prefix – "no nothing." This is especially pathetic to hear when he is the only one left calling after everybody has gone to the listening cycle. Giving the phonetics of the DX station is downright insulting. It is tantamount to telling the DX he doesn't know his own call.

"What's your number again?" may not be correct grammatically, but it is more effective than "I would like to have you repeat your number." Note "what is" (he wants

something so get set), "number" (it's my number he wants), "again," (he means repeat). The sequence is "get set" "for the query" "reinforce." This technique also works for copying high speed CW.* Note that in "I would like to have you repeat my number," the only part that carries information is "repeated number."

"William David Two Dog John and a Baker" is just as bad as "Kay Nine Dog and a King" (K9DK). The DX is apt to call you K9DNK. As my friend K4II says "If I send K4II "k" meaning "ar" on CW, I'm done for because they will insist on calling me K4IIK." This is just as bad as calling KH6IJ, K5BIJ, or KS6IJ on CW. I just can't shake them loose once the imprint is fixed, but on phone thanks to phonetics, corrections can be made.

Getting attention in a pileup calls for the skill of a seer. One must be able to place himself in the framework of the DX'er and be able to outguess the competition, and still not arouse the ire of the DX'er.

If you want to put these ideas to a test, come to Hawaii and operate in a DX contest. As for me, I don't care about fancy footwork, I just go back to the first caller I can make out who signs early.

Getting Your Extra Class License

Part IV — Radio Waves

The whole purpose of radio is to communicate, and to do so requires that information be transmitted from one place to be received elsewhere. The difference between radio and other forms of communication is that, in radio, we transmit this information over "radio waves" rather than by means of wires or the printed page.

To use radio for communication we must have some knowledge of the way in which radio waves work, and so the Extra Class license examination includes a number of questions to test your knowledge of radio wave propagation.

In fact, it includes too many such questions to cover adequately in a single installment of this series. This month we'll look at the general principles involved, and some of the more unusual aspects of VHF propagation. We'll handle the following questions from the FCC study list:

48. How do the directivity of an unterminated "V" antenna and a parasitic beam antenna compare?
58. What are aurora-reflected VHF signals? If such a signal is heard, what does it sound like?
67. What constitutes a parasitic antenna element?
71. List some different types of beam antennas.
76. What determines the skip distance of radio waves?

As usual, we'll extend the scope of these questions to cover the subjects more fully. For a start, we'll examine the whole problem by asking "What Is Radio Communication?" We will find, while exploring that subject, that signals are both radiated and reflected in the process of being used to communicate.

Our second and third questions will look in more detail at reflection, by asking first "How Does Signal Reflection Occur?" and then "How Does Reflection Affect the Signal?". The answers to these two questions will include the unusual VHF effects, and will also help us meet the final two questions.

Our final two questions will bring us into the area of signal radiation: "How Is a Signal Radiated?" will introduce the subject of antennas in general; "How Can a Signal Be Concentrated?" will focus our attention on directive antennas.

While we'll get no farther in this month's instalment, future discussions will extend our study of antennas in the same direction.

All set? Let's dive in.

What Is Radio Communication? It may seem an overstatement of the obvious to proclaim that the whole purpose of radio is to communicate – yet many of us are so involved with the purely technical aspects of radio and electronics that we tend to lose sight of this basic fact. For this reason it's worth while to stand back at this point and try to find out just what is involved in communication by radio – or "radio communication".

Let's try to find out what is involved by doing some "word substitution". What we want to know is simply "What Is Radio Communication?" If we can substitute other words or phrases for the words "radio" and "communication", we may have a meaningful answer.

We'll tackle the hard one first – what can we put in the place of "communication"?

This is hard because the question of what constitutes communication has been stumping the experts for years, and promises to continue doing so for some years to come. About all that they agree on is that communication involves a "transfer of information" – so let's try that on for size.

"Radio transfer of information" still seems to make sense although it doesn't tell

us much more. Let's use that and try to keep going along this route. What can we put in the place of "information"?

Some 20 years ago, fortunately, Claude Shannon found a good answer for that one. He defined information as "a selection from a set of possible choices", and went on to define it more precisely as a reduction in the uncertainty of the selection. However when we plug in Shannon's definition of information the result looks more like a government directive than like any meaningful explanation. Let's try again, using Shannon's idea but not his words.

The simplest possible amount of information about anything is the mere fact that it exists, or does not exist. This is an all-or-nothing choice with no alternatives – and we make use of it any time we send a message using CW. The carrier is either there or it is not, and we interpret the pattern formed by its presence or absence over a period of time into characters of the alphabet which spell out the message.

Following this line of reasoning, the carrier is a radio wave and a radio wave is a form of energy. It's not unreasonable to say, then, that information *can* consist of a sequence of energy patterns. It's not even unreasonable to assume that it always consists of such a sequence of energy patterns, because an AM signal or even TV is also a sequence of energy patterns – just much more complex than the simple on-or-off of a CW signal.

And plugging this in gives us the phrase "radio transfer of a sequence of energy patterns", which doesn't seem to be too far out although it does tend to sound more like engineeringese than like English. Let's see what we can do about that.

The word "transfer" always implies a "from-to" relation; that is, it means a movement of something *from* a source or transmitter *to* a target or receiver. Let's use this fact to modify our phrase even more: "radio movement of a sequence of energy patterns from a transmitter to a receiver" is the result, and it sounds more like English if we turn words around a little to say "movement of a sequence of energy patterns from a transmitter to a receiver by means of radio".

What's more, this expansion of the simple phrase "radio communication" is beginning to look almost like a definition, which is what we set out to find!

About all we have left to do to it is to expand the word "radio" and we may have our answer.

The physicists tell us that any energy can be moved by two routes – conduction and radiation. Conducted energy moves along some physical "conductor"; direct current flowing in a copper wire is an example of conducted energy, and so is light flowing through a polished plastic rod. For that matter, the heat reaching the handle of a skillet gets there by conduction too.

Radiated energy, on the other hand, moves directly through space without benefit of a conductor. The light and heat from the sun are good examples of radiated energy. So is the *rf* output of any transmitter once it leaves the antenna. The word "radio" is, in fact, simply an abbreviation of the word "radiate"!

So we can define "radio communication" as being "movement of a sequence of energy patterns from a transmitter to a receiver by means of radiated energy". This gets us the answer to our first question, but there are a few points to clear up before we move on to the second.

For instance, the "transmitter" in the definition we have just developed is not what we generally mean when we use the word. In this definition, a "transmitter" includes the entire setup from operator and mike or key, through the transmitting equipment, to the antenna. Similarly, the word "receiver" in the definition includes the receiving antenna, receiving equipment, and finally the receiving operator. After all, communication is established only when something gets from one human brain to another – you can't do much communicating with a beacon or code wheel!

And the use of the words "radiated energy" in the definition doesn't mean that some conductors aren't involved too; the point here is that the major part of the transfer is done by radiation. We all know that any radio equipment is full of wires. The story is told of a British dowager in the early days who, upon being shown a "wireless" station, asked "Why do you call it wireless? I've never seen so many wires before in my life!

In fact, communication by radio involves the use of both conducted and radiated energy. The transmitting equipment originates the *rf* energy and puts the sequence of energy patterns into it, and all during this phase the energy is conducted by our wires and feedlines. If any of it *does* radiate at this

stage of the game, it's a major problem! That's what shielding is all about.

The antenna is the bridge between conduction and radiation. At the transmitter, the energy is conducted to the antenna, and radiated from it. At the receiver, the antenna picks up the radiated energy, and the energy it receives is conducted into the receiving equipment.

So long as our *rf* energy is being conducted, it follows most of the normal rules which apply to dc and low-frequency *ac* (with a few exceptions such as skin effects). When it is radiated, the special rules which apply to radiated energy get into the act.

It might appear most logical to move from here directly into our examination of the bridge between conduction and radiation, the antenna. However, action of many types of antennas involves the rules of radiated energy rather than those of conduction, and so is easier to comprehend with a knowledge of these rules. For that reason we'll examine the rules of radiated energy next. Then we'll move on to look at the antenna situation.

How Does Signal Reflection Occur? Reflection of a signal is just one of two effects which occur when radiated energy meets anything. To find out how a signal is reflected, we must examine the way in which radiated energy interacts with anything it meets.

It's easiest to understand by keeping in mind that *light* is also radiated energy; any rule followed by an *rf* wave must also be followed by light, and any rule obeyed by a light beam must also be obeyed by *rf.*

It's also important to keep in mind that the rules which determine action of waves, while simple enough in themselves, are at the very heart of all modern physics. Most engineering textbooks make no effort to explain the rules – they merely state that the rules are followed.

One volume which does attempt to explain them in detail (Fields and Waves in Modern Radio, by Ramo and Whinnery) makes generous use of matrix algebra and differential equations derived from Maxwell's Equations to present the explanation.

But we're not afraid to take a chance on oversimplifying a complex subject in the interests of getting the main part of the idea across; we may make a few minor errors along the way but in general the following explanation is how it works.

And you won't find the slightest trace of mathematics in it, either.

A word of warning is in order, however. While the main idea is presented accurately, don't get into any arguments with physicists and cite this material as your reference. It may not be all that accurate; in case of conflict, believe the physicist!

If you're still with us, then, let's dive right into just how "wave mechanics" and "quantum theory" describe the interaction of radiated energy and matter.

While nobody yet knows exactly what a "wave" of radiated energy amounts to or just how it manages to get from here to there, a number of ideas and concepts (the big brains call the "models") have been developed – and most of them seem to fit at least parts of the needs pretty accurately.

One of these ideas, which is the basis of quantum theory, is that a wave consists of minute packets of energy called "photons" and that the amount of energy per packet is related to the frequency of the wave. The higher the frequency, the more energy per packet.

In this scheme of things, a light wave packs more punch than does a radio wave, and an X-ray has more punch than either.

The effects which we observe in waves, such as those of reflection, refraction, diffusion, or scattering, occur only at the boundaries where the wave moves from one substance to another. So long as a wave is travelling in a single medium, whether that medium is air, a sheet of plastic, glass, or the unknown substance today's scientists call merely "space" and the learned men of an earlier era knew as the "aether", it can produce no observable effect!

At the boundary which separates one medium from another, though, one major effect occurs. This effect shows up as two distinct phenomena – and it's only because of them that we can tell that waves exist.

The effect which occurs is an interaction between the wave's energy and the particles which make up the medium; normally these particles are atoms, but sometimes they are molecules and in a very special case they include electrons as well.

The particular type of interaction which occurs depends upon the relationship between the frequency of the wave and the self-resonant frequency of the particles involved. Each of the particles of atomic or molecular size *does* have a self-resonant frequency, and it's most convenient to think of them as being tiny tank circuits exposed

to an excitation from the incoming wave.

If the incoming wave is at a frequency far below that of the particle's resonance, the particle will vibrate weakly in phase with the incoming wave.

If the incoming wave is at a frequency far *above* that of the particle's resonance, the particle will still vibrate weakly at the frequency of the incoming wave, but its vibration will be 180° out of phase with the incoming excitation.

If the incoming wave's frequency matches that at which the particle is resonant, the particle will vibrate strongly, 90° out of phase with the incoming wave.

In most materials the particle resonances are at frequencies higher than that of visible light; a few substances have resonances as low as the infrared region, but almost none have resonance in the common *rf* range.

For this reason, for most *rf* energy and almost all materials the first case will hold true. Each particle at the boundary of the material will vibrate weakly and in phase with the incoming wave.

There's a very special exception which we will meet a little later, in which both in-phase and out-of-phase vibrations occur. Before we look at that, though, let's stay with the first case and see what happens most of the time.

Now as it happens, a vibrating particle will itself emit new radiation just because it's vibrating. It's the same basic idea as that of the tuning fork, which you hit to make vibrate, and which then emits an audio wave because it is vibrating.

This means that when an *rf* wave hits the surface of any substance, each particle at the surface of that substance will re-radiate new waves which are in phase with the original *rf*

Each of these new waves will, in turn, hit adjacent atoms or particles within the material and cause additional vibrations and more re-radiation.

If the particles are scattered about the substance more or less at random, as they are for instance in a gas, the total effect of all this secondary vibration will be a "scattering" or "diffusion" of the original wave. The higher-frequency waves in the original energy (if a mixture of frequencies were present at the start) will predominate in the scattered new radiation, because they had more energy per photon to begin with.

We see such an effect any time we look at a blue sky. The blue skylight is the scattered

re-radiation produced by the molecules of the air when they are hit by sunlight; the red of the sunlight is dissipated in the scattering process.

If the particles are held in a reasonably rigid structure, though, as they are in most solids, the effect of the new radiations is rather different.

All of the individual re-radiations from the individual particles tend to cancel each other out, because the particles are regularly spaced. The only re-radiations that are not at least partially cancelled by this effect are those which happen to add up in "coherent phase" travelling in just one direction inside the material, and those from the surface layers of particles which have no other particles above them to produce cancelling re-radiation.

The new wave inside the substance is known as the "refracted" wave. It may move at a different speed than did the original, and in a different direction as well, depending entirely upon just how the particles of the substance are arranged in their rigid structure.

The particles at the surface (a layer about half a wavelength deep) are producing re-radiation in all directions. These re-radiations all interfere with each other, just as do the cancelling ones inside the substance, but just what happens when they interfere depends upon the structure at the surface.

If the surface of the material is smooth (using the wavelength of the incoming radiation as the yardstick to determine smoothness; anything with irregularities no more than 1/10 wavelength apart is considered "smooth"), then the radiations from the particles at the surface will interfere with each other just as do those inside the material to produce a single wave travelling in a single direction.

The interference is normally such that the new wave from the surface particles – known as the "reflected" wave – leaves the surface at the same angle with which the original wave arrived, but in the opposite direction. This is the classic law of optical reflection as shown in Fig. 1.

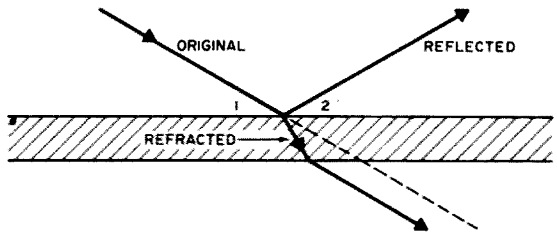

Fig. 1 — Classic optical example of reflection and refraction shows that reflected ray always leaves surface at same angle it arrives. Refracted ray changes direction at boundary. If refracted ray passes through another boundary, as shown here, its direction changes again; if two boundaries are parallel to each other final ray will be parallel to original ray (dotted) but offset from its path. If boundaries are not parallel, as in a lens, rays may be either spread apart or focussed to a point. Same effects are present in radio waves but because wavelength is much larger the effects show up somewhat differently.

If the surface is rough (irregularities more than 1/10 wavelength apart), then the reflected waves from each surface particle will not add up to a single wave since each will have travelled a different distance at any given point away from the surface. Reflection still occurs, but it is diffuse rather than sharp. A white cloud offers an optical example of this. So, for that matter, does the white surface of the paper on this page; the paper particles are much larger than the wavelength of light, and so the light falling on the page is reflected diffusely. Where the ink is heavy, it forms a coating with a surface structure smaller than 1/10 wavelength of light, and so appears glossy with sharp reflections.

Since both light and *rf* waves are the same type of electromagnetic radiation, differing only in frequency, *rf* acts just the same way light does. The apparent differences are due to the vast difference in frequency; a structure which is quite smooth to an *rf* wave may consist of such widely scattered particles that it appears totally transparent to light. A screen-wire reflector is a good example of what we mean here. Another example is the ionosphere, although its relative smoothness differs for *rf* of different frequency.

Because of this, when a radio wave hits almost anything both reflection and refraction will occur. The reflection is the basis for radar, and the refraction makes skip propagation possible (as well as possibly providing the mechanism for radio to exist in the first place, if you consider the "radiated" wave as being refracted through space).

But before we go any further we must examine the very special case of materials which are electrical conductors, because they behave rather differently than the ordinary solid substances we have been examining.

an insulator lies in the atomic makeup of the

material. A conductor contains numbers of "free" electrons which are bound only loosely to their parent atoms and which are free to wander about the interior of the material under the influence of electric forces. A perfect insulator has no such electrons, and actual insulators have very few.

The free electrons in a conductor provide the means by which an electric current is conducted, and also make a large difference in the action of the material when a wave hits it, because both the free electrons *and* the particles which make up the substance's structure at the atomic level vibrate.

The particles vibrate weakly, in phase with the incoming wave, just as do those of insulators. The free electrons, on the other hand, vibrate *out* of phase with the incoming wave by 180°, also weakly.

The vibrations of the free electrons cancel out the vibrations of the particles, and make it impossible for the wave to penetrate the boundary of the substance. Refraction cannot occur, because the energy can't get inside the material.

But the energy is still striking the surface, and the surface layer of particles is still vibrating. This permits reflection to occur. What's more, the law of conservation of energy requires that all energy going into something must come out again – and since no refraction can occur, *all* the energy taken from the incoming wave is reflected from the surface.

Thus a conducting surface will reflect all the *rf* which hits it, while an insulating surface will reflect only a part and will refract the rest through itself.

Conducting reflectors play a large part in antenna design; the principles of reflection (particularly that of re-radiation) are also important in understanding action of parasitic antennas.

The effect normally known as "signal reflection", though, is more often actually due to refraction than to reflection. Such things as skip transmission, meteor trail communication, and aurora-reflected signals are actually effects of refraction. Moonbounce and scatter work, however, are true reflection phenomena.

The reason why refraction can masquerade as reflection is illustrated in **Fig. 2**, which shows refraction at work in one of the ionized layers responsible for skip transmission.

When a wave is refracted, both its speed

and direction usually undergo change. Speed may either increase or decrease; the change of direction usually depends upon what happens to the speed.

If the refracting medium has characteristics which change gradually within the material, the speed and direction of the refracted wave will also change gradually as the wave proceeds in the material.

The ionized layer is such a medium; its makeup changes – both from minute to minute (and other periodic changes) and at various points within the layer at the same time.

Thus a wave transmitted from the earth will be bent or refracted only slightly as it enters the ionized layer, but the deeper it penetrates into the layer the more its direction is changed. When the original direction has been changed enough to turn it around a corner, the wave is moving out of the material rather than in, and then the change in direction becomes less the farther it travels.

Eventually the wave will come back out of the layer, provided that the refraction doesn't just happen to trap it completely within the layer and bend it only enough to keep it trapped. Even if this should happen at some spot, there are enough irregularities in the layers that the energy would escape elswhere – and such an action may be at least partially responsible for some types of fading.

As Fig. 2 shows, when the wave emerges from the layer there is no way at all you can

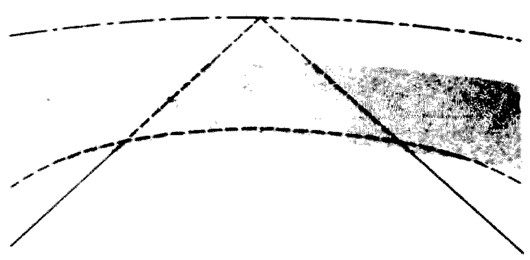

Fig. 2 – Refraction of radio wave in ionosphere is cause of apparent "reflection" of skip signals as shown here. Since ionization level changes gradually within an ionized layer, angle of refraction is continually changing. This bends wave back in new direction, making it appear to have been reflected from a surface at somewhat greater height (dashed line). Wave reaching layer at shallow angle (dotted) does not penetrate so deeply as one hitting at sharp angle (solid); therefore it is bent less and so returns to earth at greater range than difference of angles alone would indicate.

determine that it wasn't simply reflected from a sharp surface at a somewhat greater height. This fictional reflecting surface's height is what is referred to as the "virtual height" of the skip layers.

The reason we know it works by refraction rather than reflection is that the virtual height of a layer appears to change with the angle at which energy hits it. The shallower the angle, the lower the virtual height. You can see from the dotted-line example in **Fig. 2** that this would be expected with refraction, but not with reflection.

This mechanism in the ionisphere indicates that the angle at which the signal will be "reflected" depends critically upon the angle at which the signal arrives, and also upon the condition of the ionized layer at that particular time. High-frequency signals packing more punch per photon, bore right on through much more readily than do those of lower frequency – so that as you keep going up in frequency, you find a point at which the signal simply doesn't come back down. Instead, it bores on out headed toward outer space.

The angle at which the signal hits the layer depends, in turn, upon the actual angle at which the wave leaves the transmitting antenna. This depends upon the antenna design, its height above electrical ground, and the nature of the ground surface within several wavelengths of the antenna site. The lower the angle at which the signal leaves, the more shallow will be the angle at which it hits the refracting layer, and the greater will be the distance covered before it returns to earth.

Any substance which is capable of refracting the wave can cause "reflection" by refraction in this same manner. In addition to the horizontal ionized layers which make up the ionisphere, *rf* signals are frequently "reflected" from the aurora borealis and from the trails of ionization left behind by meteors. At VHF, similar effects are caused at the boundary between different layers of air in the atmosphere.

How Does Reflection Affect the Signal? True reflection has virtually no effect upon the signal, except that its phase changes 180° during the process of reflection. "Reflection" by means of the refraction effect, though, can affect a signal in many ways.

Reflection of VHF signals from the shimmering veils of ionization which are known to science as the aurora and to the general public as "the Northern lights" offers several examples of such effects.

The aurora is a rapidly moving affair. Its

exact cause and composition is still not accurately known, but it is believed to be especially intense ionization of the upper atmosphere under influence of solar radiation trapped by the earth's magnetic field. It is visible as curtains, columns, and sometimes horizontal sheets, and moves in both the horizontal and vertical planes at relatively high speeds.

Often, the aurora appears to shimmer with a to-and-fro motion.

Any radiation reflected (that is, refracted back toward the source) from these clouds has a frequency shift imposed upon it by the motion of the clouds, by Doppler effect.

This frequency shift is, effectively, FM of the original signal, in which the modulating signal is the oscillating movement of the aurora itself.

The frequency of the aurora's oscillation is often so great that the resulting FM completely wipes out any intelligibility of audio upon the signal, and makes a CW signal appear to occupy a wide band rather than the normal near-zero bandwidth.

If aurora-reflected signals are received by the normal CW method, using a product detector or BFO, the FM causes the received signal to appear to warble. But since the reflection is coming to the receiver from a wide source – the entire aurora cloud – and part of it is moving toward the receiver while other parts are moving away, it isn't just a single warbling note. Instead, it's a mixture of frequencies covering the entire audio range. The resulting sound has been compared to the whine of a buzz saw going through a pine knot . . .

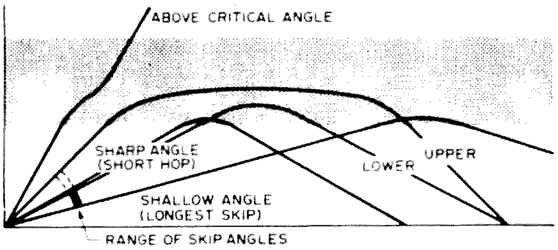

Fig. 3 – Various effects of transmission angle (angle at which wave leaves transmitter) are shown in this sketch. The longest skip distance is achieved by the wave with the lowest transmission angle, and the shortest by that with a moderately high angle. As angle increases, wave is held in ionized layer longer and skip distance increases again. Such waves are called "Pedersen waves" and may interfere with lower waves from same transmitter as shown. Still greater angles permit wave to pass on through ionized layers if ionization is sufficiently weak.

Just to complicate things, most aurora-reflected signals are very weak; very little of the original signal is reflected to any one receiver. The signal-to-noise ratio is often as low as zero db.

Somewhat the same situation prevails when the trail left by a falling meteor provides the refracting ionization. In this case, though, the warble is absent. Any Doppler shift is usually constant. Signal levels, however, are much lower because the refracting volume is much lower.

Scatter techniques depend more upon true reflection, of the same type that makes an oncoming automobile's headlights visible over the rim of a hill on a foggy night. The original signal is reflected in all directions by tiny discontinuities in the atmosphere (tropo scatter) and ionosphere (ionospheric scatter). Scatter transmission provides the most reliable and consistent form of long-distance *rf* communication, but requires power levels greater than those allowed the ham by law to attain reasonable distances with high reliability. At amateur power levels, distances are so short that most scatter signals are thought to be "ground wave" instead.

All of these effects are present with all radio frequencies, but their effectiveness varies with frequency. At moderate frequencies (15 meters and below) they are usually overpowered by "normal" skip transmission. In the VHF range they are most observable, and many VHF operators specialized in using one or more of these techniques. As the frequency goes on up, the amount of refraction becomes too small to return a usable signal level and the effect again appears to disappear.

How Is A Signal Radiated? The subject of just how an *rf* signal can be propagated is a most profound one, and virtually all the first installment of our previous Advanced class study course (March, 1968, issue) was devoted to it.

A few minor modifications to the propagation model we put together in answer to our question "How Does Signal Reflection Occur?" can, however, offer some additional insight into the subject.

As we explored reflection and refraction, we discovered that a conductor cannot refract a wave but must reflect it. At that point, we declared that the energy had no place else to go and so all the incident wave went back out as a reflection.

If, however, the conductor happens to be serving as an antenna, that statement was not fully correct. The energy *does* have some place else to go – down the feedline.

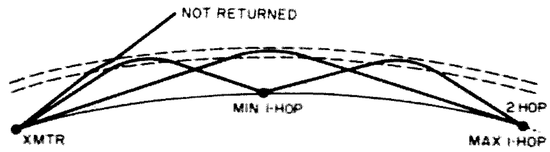

Fig. 4 – Both single and multiple-hop propagation are shown here. Wave launched at original angle for shortest skip range hits earth at moderately steep angle and is reflected back toward ionosphere. There it is refracted again and comes back down at double the original distance. "Skip distance" is distance from transmitter to the minimum 1-hop point; this region is sometimes called the "dead zone". Waves launched at higher angles fail to return (except for Pedersen waves, see Fig. 3). Those launched at intermediate angles fall between minimum and maximum 1-hop ranges.

In the case of a transmitting antenna, energy is coming up the feedline instead. In either case, the system is no longer in perfect balance.

When the frequency of the wave which is exciting the antenna is such that a standing wave can develop on the antenna structure itself, it does so. This standing wave can be thought of as the re-radiated wave from all the surface particles. However, since the standing wave maintains a perfect phase relationship with the radiated energy, it will couple with the radiation field and permit a much more efficient transfer of the energy itself.

What's more, the fields of the standing wave will induce a current *inside* the conductor – where the radiated wave itself cannot get because of reflection at the surface. This action is what moves the energy through the totally-reflecting boundary of the conductor.

If we're trying to radiate a signal rather than receive one, we begin by pumping energy into the antenna conductor at a frequency at which the antenna has electricl resonance. This produces a standing wave upon the antenna, and this standing wave is accompanied by a magnetic field which is directly associated with current flow in the conductor.

The variation in the magnetic field is accompanied by a variation in the electric field established between the ends of the antenna conductor, and the phase relationships between the magnetic and electric fields which result are such that the "wave" which they define is a travelling wave rather than a standing wave.

A travelling wave is, by definition, one which is being radiated through some medium – usually "space". A standing wave, on the other hand, is confined to a physical structure such as an antenna.

While most antennas radiate by means of a standing wave created upon their structure, this is *not* an absolute requirement. Any resonant antenna has a standing wave, and so do such "non-resonant" antenna types as the long wire.

The terminated V, the rhombic, and the Beverage antenna designs, however, all make use of travelling waves without requiring a standing wave as well.

Travelling-wave antennas are inherently less efficient in the transfer of energy for a given amount of wire; the absence of the standing wave to help couple energy from inside the conductor to the outside of it must be paid for in a much larger structure. Travelling-wave antennas are almost invariably several wavelengths long, while the most common standing-wave antenna is the half-wave dipole, and the quarter-wave whip is no rarity either.

The difference is brought about largely by the difference in current distribution in a travelling-wave antenna as compared to a standing-wave antenna. **Fig. 5A** shows the familiar standing wave of current upon a resonant antenna; **Fig. 5B** shows the current distribution on a travelling-wave antenna.

The difference is marked; in the resonant antenna, current is highest near the center and drops to virtually zero at each end, while in the travelling-wave antenna the current is essentially constant throughout the conductor, dropping only because of radiated energy.

Those portions of the conductor which carry the greatest current are simultaneously surrounded by the strongest magnetic field since the magnetic field and the current are closely associated.

As this magnetic field couples to its surroundings, each tiny portion of the antenna acts as if it were a separate source of radiation.

With the constant current in the travelling-wave antenna, all these separate sources are radiating in essentially the same phase (the only phase differences are those introduced by the physical length of the conductor) and at essentially the same strength. The result is an interference pattern which causes most of the individual fields to cancel each other out just as did the re-radiation of

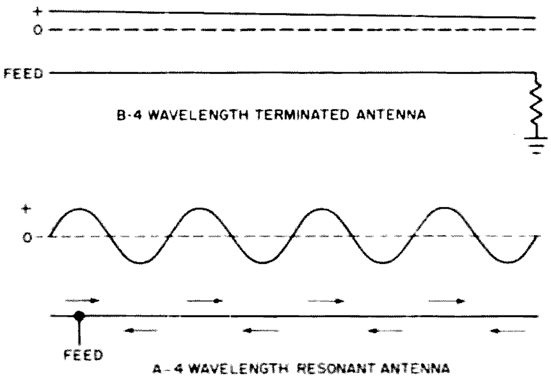

Fig. 5 — Difference in current distribution between resonant antenna (A) and terminated or travelling-wave antenna (B) creates differences in radiation patterns. On resonant antenna, current goes in different directions at different points to create standing wave. On terminated antenna, current flow is all one-way, from feedpoint to termination. Both antennas are shown as being "current-fed" at maximum current points.

individual particles in refraction. Those which add up instead of cancelling become travelling waves leaving the antenna.

In the resonant antenna, the separate portions of the conductor are not necessarily in phase with each other because the total reflection at the ends of the antenna introduces a 180° phase change, and they most certainly are not of equal strength as radiators since the current is not constant. Mutual interference still operates to cancel out most of the fields and leave a radiating travelling wave – but the pattern is different.

The most noticeable difference is that the travelling-wave antenna is unidirectional while the standing-wave antenna is not. This is because the current in the travelling-wave antenna is flowing only one way, while in the standing-wave antenna current is flowing in both directions (out and back) at the same time to create the standing wave.

Fig. 6 compares the directional patterns for a terminated long-wire antenna (a travelling-wave type) and for a resonant long-wire of the same length.

A key point to keep in mind concerning signal radiation is that each individual small part of any radiating structure, such as an antenna, radiates with equal strength in all directions. Its radiation pattern is essentially a perfect sphere.

However, any radiating conductor which has any length at all must be composed of many such small parts, and each of them is radiating in slightly different phase from all the rest since the exciting energy takes at least a little time to get from one to another, and phasing *is* time delay.

The result is that any possible (as opposed to theoretical) antenna must have some type of radiation pattern, which is the result of the interference pattern created by the individual spherical patterns of its individual parts. That's why we looked at refraction and reflection first; the exact same principle is involved in the creation of the radiation pattern for any antenna, and as we shall discover shortly is also involved in our efforts to concentrate a signal in a desired direction.

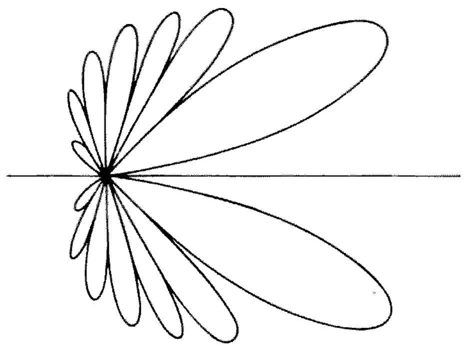

Fig. 6 — A — Radiation pattern of terminated antenna four wavelengths long is unidirectional in general direction of the wire, but has a null directly off the wire's end. The pattern's main lobes make 26° angle with wire. Pattern is symmetrical in three dimensions; consider this a cross-section view of it looking down from top.

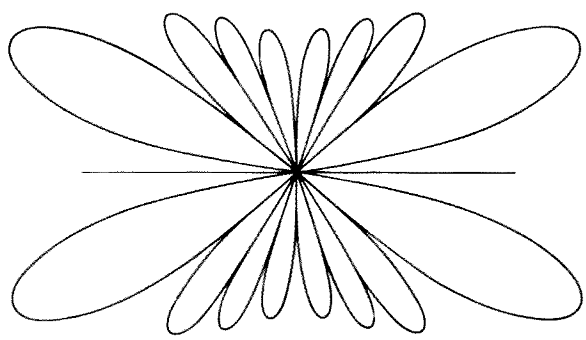

Fig. 6 — B — Resonant antenna of same 4-wavelength length has this type of pattern; it's like the terminated antenna's pattern with a mirror image superimposed on it. Result has main lobes in both directions, still with 26° angle and symmetrical shape. Bidirectional current flow (Fig. 5) is directly responsible for this bidirectional pattern.

How Can a Signal Be Concentrated? The "isotropic" antenna, which doesn't exist in practice but is the basis of antenna theory, radiates any power applied to it with equal strength in all directions. Its radiation pattern is a perfect sphere.

As we just saw, any possible physical antenna must be made up of several different atoms and so cannot be a perfect isotropic antenna – but even if we could get one, nobody would want it. *rf* power is too difficult to generate to waste by beaming as much signal straight up into space and straight back down into the ground as we send in the desired directions!

Any practical antenna performs at least some concentration of its signal, then, by putting it all into its radiation pattern. What we're really concerned with here is how we can concentrate the signal even more. It would be nice, for instance, to be able to put all our power in just the direction we wanted to transmit, without wasting any of it in undesired directions.

Such antenna designs exist, of course, and are known by the general name of "beam antennas" since their purpose is to concentrate as much of their power as possible into a single beam.

At least four major types of beam antennas have been developed, and many different designs within each type bear individual names. The types are (1) driven arrays, (2) parasitic arrays, (3) reflective systems, and (4) travelling-wave antennas.

Driven arrays include broadside arrays, endfire arrays, and combinations of the two. The Lazy H, ZL Special, 8JK beam, and Franlkin Collinear array are examples of driven arrays, as are most directive BC-station installations.

Almost all parasitic arrays are of the endfire type; the most common such design is the Yagi antenna.

Reflective systems are used primarily in the UHF and higher-frequency regions, and include the "big dishes" and the corner reflector.

Travelling-wave antennas include the terminated V, the rhombic, and their variations; these are most usually used only at low frequencies where the other types of beams are not practical. One type of travelling-wave antenna in wide commercial use at high frequencies is the helical beam.

Any single beam antenna installation may mix or match these types. Especially popular among VHF workers is a combination of driven and parasitic arrays in which several separate parasitic arrays are driven at the same time to form a driven array of parasitic arrays. Fig. 7 shows the idea. At UHF, a

corner reflector is sometimes incorporated into a parasitic array to increase the beam concentration and reduce unwanted back-lobes.

Since most beam antennas in ham use are either driven arrays, parasitic arrays, or combinations of the two types such as that shown in **Fig. 7**, we'll concentrate on only these two types for now.

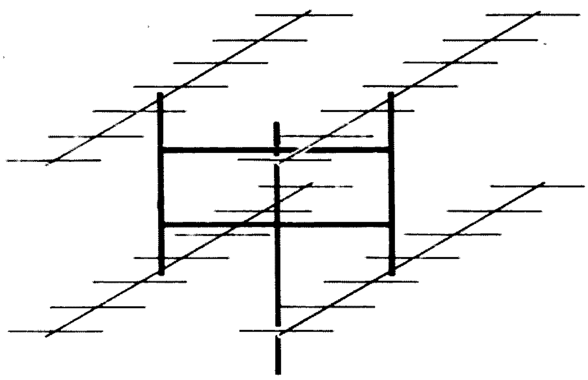

Fig. 7 – Quad Yagi antenna installation popular with serious VHF enthusiasts is typical example of an array of arrays. Each of the four Yagis is itself a parasitic array, and the four are arranged and fed as a two-by-two broadside driven array. Result is highly directional pattern and maximum gain; as much as 18 db power gain can be achieved in practical amount of space with careful design and adjustment.

The driven array consists of a number of individual antennas arranged in some regular pattern, all of which are driven at the same time from the same source. It's exactly the same principle as the radiation from separate atoms in refraction, except that it's at a much larger scale.

Fig. 8 shows the essential portions of any driven array; each individual antenna is shown here only as a dot rather than as a wire, because it's easiest to see what's happening if we think of each individual antenna as an "isotropic" one for the moment.

If each of the individual antennas is fed with current of exactly the same phase, then the array is a "broadside array" because it will concentrate the pattern to be strongest in the directions broadside to the line of the antennas. That is, the pattern shown in solid lines will result.

This is caused by interference between the patterns of the individual antennas. Only at point P (and other points along the line between P and the center of the array) will a receiver get equal amounts of in-phase energy from all the individual radiators. At other angles, the waves from one antenna must travel further (and so take longer en route) than those from another, and so will arrive out of phase. This causes a partial cancellation. The pattern is the result of all these partial cancellation effects.

If, however, the antennas are fed differently, the pattern will change. For instance, if the feedline is connected directly to the leftmost antenna and goes to the adjacent one through an additional length of cable which introduces a phase delay, and so forth down the line, and if that phase delay is chosen just right so that the energy *feeding* each array is in phase with the energy arriving from its neighbor to the left, then the only point at which all antennas contribute equally is that marked Q. The resulting radiation pattern is shown in dotted lines in **Fig. 8**, and the array is now an "endfire

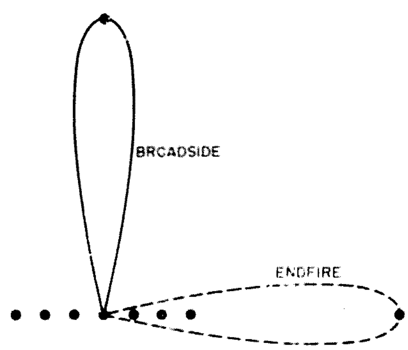

Fig. 8 – Basic patterns of driven arrays are broadside and endfire as shown here. For simplicity, each element of this array is shown as an isotropic (point-source) radiator and all minor lobes have been omitted. Both patterns repeat themselves in opposite direction; that is, they are bidirectional. Difference in direction between broadside and endfire patterns is due to feedline phasing within array; main lobes can be tilted to any in-between angle by proper phasing but this is not usually done with ham antennas.

array" since it fires its strongest beam off the end of the line of antennas. The only change necessary to obtain this 90-degree change in direction was to change the phasing of the feedlines.

By appropriate choice of phase relationships between the various antennas in a driven array, the beam can be tilted to any point between the broadside position and the endfire pattern. This is done in BC-station design, but in ham work it's much easier to simply rotate the array.

If, instead of the imaginary isotropic antennas we used in **Fig. 8**, the individual elements of the array are dipoles (as they

usually are) then the radiation pattern of the dipole gets into the act. Broadside arrays made up of dipoles are usually set up either parallel to each other, or end to end, as in the "colinear" antenna. Endfire arrays of dipoles on the other hand usually have the antenna conductors arranged at right angles to the line of radiation, like the Yagi parasitic array (which has an endfire radiation pattern).

A parasitic array is essentially a driven array in which only one of the antennas is actually driven, and the rest pick up their energy by radiation from that one. Most parasitic arrays are endfire designs, since it's simple to get the necessary coupling and phase relationships from parallel dipoles.

The phase of the energy actually radiated from an antenna depends, in part, upon the relationship of the exciting energy's frequency to the frequency at which the antenna is self-resonant. The phasing adjustment which, in the endfire driven array, was made by adjusting feedline length, is made in a parasitic array by tuning the parastic (non-driven) elements to frequencies slightly different from that at which the antenna is to operate.

If an element is tuned to a frequency slightly lower than that at which operation is desired, the phase of its reflected or re-radiated energy will be such as to cut down the radiation pattern in its direction, and build it up in the opposite direction. Such an element is called a "reflector".

If an element is tuned to a frequency slightly higher than that at which the beam is to operate, it will build up the radiation pattern in its direction and cut it down in the opposite direction. Such an element, since it directs the pattern in its own direction, is called a "director".

The spacing between the driven element and the parasitic elements is just as critical, in a parasitic array, as is the tuning of the parasitic elements, since the array's performance is determined, by relative phase over the entiré structure. Distance determines phasing also. For any specific tuning of a parasitic element, there is a critical distance as well.

Before the principles of the parasitic array were understood as well as they now are, this led to many conflicting rules for design of parasitic beams and their tuning. About 10 years ago, however, it was discovered that the critical factor actually is the combination of tuning and spacing. It is now

known that almost any spacing (within reason) can be used, or alternatively almost any tuning of element lengths. Once a spacing is chosen, then the tuning of the elements must be matched to it; if element tuning is chosen first, then the spacing must be adjusted to obtain maximum performance.

In comparison to the other three types of beam antennas, parasitic arrays offer the highest performance per unit size. On paper at least, you can get any desired gain from a physically small parasitic array if you just use enough elements and tune and space them properly. In practice, the gain really is limited – but you can get a 10-time increase in effective radiated power from an antenna only a half wavelength wide and a wavelength long, which is much more than any of the other types of beam can provide. For this reason many engineers call such designs "super-gain" antennas.

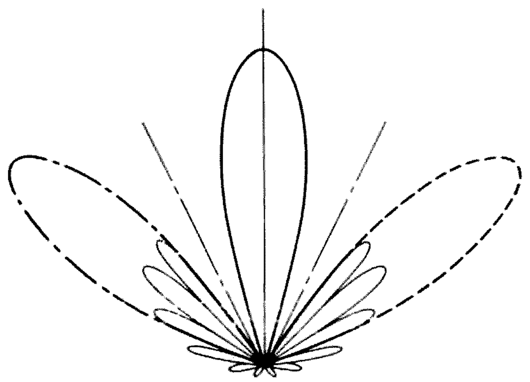

Fig. 9 – Buildup of radiation pattern for terminated V antenna with each leg 4 wavelengths long is shown. Each leg of V by itself has pattern of terminated long-wire (Fig. 6); legs are placed at proper angle to make main lobes coincide in one direction, and cancel out to at least some degree in all others.

The travelling-wave antenna, such as the rhombic or the terminated V, gets its gain by a cancellation effect also. As **Fig. 6** showed, a travelling-wave antenna is inherently unidirectional – but puts its power into a cone rather than a beam. If two such antennas are erected side by side to form a V as shown in **Fig. 9**, their patterns can be made to cancel each other out in most directions while they add together in just one and form a single beam of radiation. This is the terminated V. If the terminations at the wide end of the V are removed and another pair of antennas is put in their place, with terminations at the narrow end **(Fig. 10)**, you have the rhombic. Gain of such an antenna is moderately high,

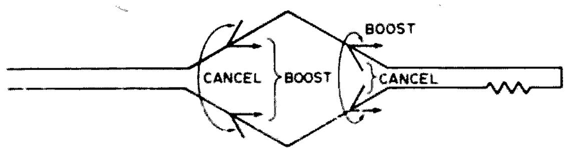

Fig. 10 – Simplified buildup of pattern for rhombic antenna is similar to that for terminated V; lobes aimed in same direction boost each other and all the rest cancel. Cancellation is more complete in rhombic.

but is nowhere near that to be expected from either a driven array or a parasitic of similar size – because each leg of the rhombic needs to be at least four wavelengths long to get the directive effect.

You can also get some directivity from an *un*terminated V. This is essentially two long-wires side by side. The cancellation effect still works to take out part of each long-wire's pattern, but the resulting beam is bidirectional with its major lobe splitting the V angle as shown in **Fig. 11**.

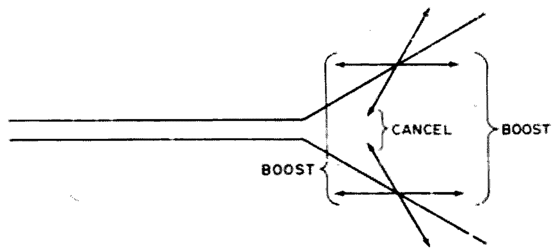

Fig. 11 – In unterminated V antenna, lobes in both directions boost each other but side lobes cancel out. Result is bidirectional beam, similar to that of broadside or endfire pattern from driven array.

The resulting pattern is similar to that you get from a simple driven array **(Fig. 8)**. A parasitic array, on the other hand, concentrates its power essentially in a single direction, as does the terminated V or the rhombic.

The subject of antennas and how they work is one of the most important in ham radio, because nowhere else can you get such an improvement in your station's performance for a comparable amount of effort. We'll be going into it more in our next few installments, but even then we will not be able to cover it completely – the subject is just too large.

A number of books are available at various levels of technical knowledge. The traditional authority on the subject is "Antennas", by John Kraus, W8JK, inventor of the 8JK beam, the corner reflector, and the helical beam. Terman's "Electronic and

Radio Engineering" contains much valuable data at a slightly less exotic level, being intended as an undergraduate text for engineering students at the college junior/senior level. "Fields and Waves in Modern Radio" by Ramo and Whinnery handles the basic principles of radiation excellently but requires at least an acquaintance with higher math (matrix algebra and partial differential equations) to read comfortably. Jasik's "Antenna Engineering Handbook" is intended for the antenna design engineer but avoids much of the deeper theory and concentrates on practical applications instead. Any or all of these are recommended for additional study, if you're really interested in adding to your knowledge of how and why antennas work as they do.

Next Month. We'll continue examining antennas, looking at such factors as harmonic rejection and feedline matching.

RENEWAL CODE

The two numbers under your call on the address label are the expiration code. We have tried to make it simple. The first number is the month that we send you the last copy on your subscription and the second number is the year. 78 would be July 1968, for example.

73 MAGAZINE

Loosen Those Army Set Screws!

One of the big problems faced by every would be user of the Command Transmitters is the frustrating task of loosening those special set screws on the knobs and shafts of this series. Usually one ends by using brute force and damaging the part, or just laying the equipment aside.

One of the regular screwdriver blades in the SC-5 Screwdriver set which can be purchased from the radio houses, or any good screwdriver with a very small blade will just fit into this set screw and with a stout twist will loosen any of them very quickly. If this screwdriver set is not available, grind any stout screwdriver down to about 1/16th of an inch, and they will fit into these set screws cross-wise.

The knobs and shafts of this Command series suddenly become very valuable.

Irvin Kanode, WA9CKP

NEW BOOKS

Electronics for Technicians

Written by Abraham Marcus and published by Prentice-Hall, Electronics for Technicians is a sequel to Electricity for Technicians. It describes electronic phenomena in physical terms, rather than mathematical and is extremely well-written.

The book is divided into three sections. Section I deals with the electron tube. The various types of tubes are discussed in language which almost anyone with any electronic knowledge can easily understand. Section II discusses semiconductor theory and the various types of semiconductors are examined. Section III deals with how tubes and semiconductors are used in various circuits including power supplies, amplifiers, oscillators and various circuits used in the home, in industry and communications. Mr. Marcus gives an overall view of the subject and his book should serve as a basic foundation for further study in electronics.

The book is divided into 20 chapters within the three categories, and each chapter is followed by a series of questions for the student to test his comprehension of the material. Following the 20 chapters is a series of apendices showing pin identification for electron tubes, lead identification for various transistors, and a complete section on electronic symbols which is the most up-to-date I have seen so far.

In an attractive cloth-bound cover, Electronics for Technicians sells for $9.95 and certainly contains all the study material needed for anyone interested in learning basic theory.

RCA Manuals

The RCA *Solid-State Hobby Circuits Manual* contains complete construction information on 35 circuits of general interest to experimenters. Power supplies, oscillators, keyers, preamplifiers, amplifiers, and numerous other items are covered in detail. This manual also contains sections on theory and practical application of most solid state devices, and gives information on construction practices and trouble-shooting.

The revised and expanded RCA *Receiving Tube Manual* contains up-to-date information on tube types and technology; detailed descriptive data and application information for the complete line of home-entertainment types of receiving tubes for TV and Hi-Fi enthusiasts.

Seven other technical manuals are available from RCA. *RCA Transistor Manual* is a 544 page book containing text, data, and typical circuits for the complete line of transistors, silicon rectifiers, and other semiconductor diodes.

RCA Silicon Power Circuits Manual is a 416 page book providing design information for a broad range of power circuits using silicon transistors, rectifiers, and thyristors.

RCA Linear Integrated Circuits (352 pgs.) contains basic principles of design and application information for linear integrated circuits.

RCA Silicon Controlled Rectifier Experimenter's Manual is a 136 page book containing 24 interesting control circuits using semiconductor devices available in kit form.

RCA Transmitting Tubes is a 320 page book giving data on more than 180 RCA power tubes with plate input ratings up to 4 KW.

RCA Phototubes and Photocells (192 pgs.) contains design information and data for 90 photosensitive devices.

RCA Tunnel Diodes is a 160 page book containing information for RCA tunnel diodes for switching and microwave applications.

Prices range from $ .65 to $5.75. For a complete brochure and prices write Commercial Engineering, RCA Electronics Components, Harrison, N.J. 07029.

Motorola Semiconductor Handbook

The Semiconductor Power Circuits Handbook contains the latest information in power circuit design. Some 150 new circuits have been specifically designed for users of power transistors, thyristors, rectifiers and zener diodes. This 264 page manual includes many designs being published for the first time. It is divided into six chapters devoted to motor speed controls, inverters and converters, regulators, statis switches, audio and servo amplifiers, and miscellaneous thyristor switch ap-

plications. Copies may be obtained by sending $2 to Motorola Inc., Box 20924, Phoenix, Arizona 85036.

Hayden Books

This one is a beauty. The *Transistor and Diode Laboratory Course*, by Harry E. Stockman, clearly illustrates and develops the concept of transistor theory. This 117 page book is designed either for the classroom or for home study. The first half of the book is devoted to theory, providing a background in transistor technology. The remainder is experiments dealing with intricate transistor networks. Each chapter is followed by a question and answer session. For anyone who wants a more sophisticated approach to transistor theory and application, this book is a must. Available for $3.95 from Hayden Book Company, Inc., 116 West 14 Street, N. Y., N. Y. 10011.

New Books From Sams

Reference Data for Radio Engineers (Fifth Edition) 50% more information with a completely new format. Catalog No. 20678, $20.

Amateur Radio SSB Guide. Basic principles, building and troubleshooting. Catalog No. 20629, $3.95.

Learn Electronics Through Troubleshooting. A basic, practical approach to learning the fundamentals of electronics. Catalog No. 20651, $6.95.

Novel Electronics Circuits. 77 new circuits and devices to build. Catalog No. 20692, $2.50.

The Radio Amateur's FM Repeater Handbook. A 288 page book by Ken Sessions. Catalog No. 65080, $6.95.

73 Dipole and Long Wire Antennas. Covers practically every type of wire antenna used by amateurs. Catalog No. 65071, $4.50.

Amateur Tests and Measurements. Tests and adjustments to transmitters, receivers, and antennas. Catalog No. 65072, $4.95.

Ham Antenna Construction Projects. (Second Edition) Modern versions of all classic antennas. Catalog No. 20654, $3.95.

Handbook of Electronic Tables and Formulas. One book with all the charts, tables, symbols, and all you need. (Third Edition). Catalog No. 20648, $5.50.

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Know Your Tube and Transistor Testers. Trouble-shooting and repairing various makes and models. Catalog No. 20630, $3.50

Ed Baker, WØEDO
9937 Truman Road
Independence, Missouri

Economy Chronometer

How would you like to have an illuminated station clock for less than $5.00?

The unit described was built at a total cost of $3.14 plus tax, but, with a well-stocked junk box, this figure could be reduced still further.

The secret of such a bargain lies in the fact that most "electric" automobile clocks are really mechanical clocks which are wound electrically every two to five minutes. Since this winding is done by a pulse through an electro magnet, the clock doesn't care whether this pulse is ac or dc, thus making it a simple matter to power the clock in the home station.

These clocks are available from your local salvage yard, and sell for 50 cents to $3.00, depending on the condition and whether or not *you* remove it from the wreck.

The major enemies of auto clocks are moisture and dust. The latter is the most common but least damaging. In selecting a clock, pick one which shows no sign of rust on the face, hands, or any other exposed surface, and your chances of restoring it to service are almost a certainty.

To remove the clock from the case pry up the edges of the bezel which holds the glass and remove these parts. Two or three small screws or nuts in the back of the case will now allow the clock to be removed.

A large eye dropper or "ear" syringe will supply a low velocity air blast for cleaning. Do not attempt to use a brush, as fragments of the bristles will catch in the gears.

The most common cause of failure is in the winding mechanism, so a complete description of this operation is in order. On the back of the "works" is a rather large winding surrounded by a rotary armature. When this armature is aligned with the winding, the clock is wound. As the clock runs down, the armature moves away from the poles of the winding, and, near the end of its travel, a pin on the armature engages a Y-shaped yoke and closes a pair of contacts. These contacts are in series with the winding and the voltage source, so when they close, the winding is energized and the armature is drawn toward the poles of the winding. This rewinds the clock. This movement of the armature also opens the contacts by the action of the pin in the yoke. This contact between pin and yoke is where trouble develops. Just before the contacts close, the mechanism is at a point of maximum friction and minimum spring tension; so, with the collection of dust and evaporation of lubrication, the clock stops just short of rewinding.

After all traces of dust have been removed, apply a *drop* of solvent/lubricant of the type used for tuners and volume controls (Quietrol, Spra Kleen, etc.) to the yoke where it contacts the pin. Wind the clock by pushing the armature, and start it by lightly pushing the balance wheel. It will probably stop just before the contacts close. Without rewinding, start it again and let it run until the contacts do close. Rewind and repeat until it runs freely from rewind to point closure. Dry the yoke and apply a minute quantity of lubriplate (a very light lubricant cream available from hobby and gun shops) to the point of contact with the pin. If desired a small amount of the solvent/lubricant can be applied to the pivots and teeth of each gear. The smallest drop you can get is slightly too much for each point, so if you wish to skip this, the clock will probably run without it for years.

The points may be cleaned with a burnishing tool, but avoid excessive filing.

While the clock is "running in" the power supply can be prepared. The transformer can be any, which gives the proper voltage. My clock used 12 volts, so a 6.3 and 5 volt winding were connected in series to give 11.3 volts. This is plenty, since the winding is designed to work on 10-14 volts. The transformer also has a 90V winding which is not used, so the leads are taped to prevent shorts and left hanging free.

To determine the required voltage, look at the bulb in the socket which sits inside the case. If the bulb is missing, apply 6.3 ac between the input terminal and frame, and observe the armature. If it moves toward the poles of the winding (not necessarily all the

way) use 6.3. If the winding buzzes and the armature doesn't move, the higher voltage will be required.

When the proper voltage is found, let the clock run until it rewinds a few times to make sure all is well, then re-install it in the case. Most of these clocks have a cable clamp on the back which will make a convenient point for the ground connection, or a self-threading screw can be installed in a spot where it will not hit the works.

These clocks come in a variety of sizes and shapes, and take naturally to panel mounting, or a small chassis or Mini-box can be used as a case. A switch may be installed to turn off the light, if desired, but the location of the bulb is such that it illuminates the clock face and little else, so it is left on in my installation.

The transformer can be mounted in the case with the clock, or up to 10 15 feet away, depending on your needs. Lamp cord is fine for this connection.

This will not bring National Bureau of Standards or even IBM into the shack, but it is a reasonably accurate timepiece, and the price is right.

...WØEDO

4 x 150 Sockets

Larry Jack, WA3AQS
7421 Gwynndale Drive
Clinton, Maryland 20735

It was about a week after completing the small sideband rig that I realized its single watt wasn't going to be enough. After a few, "You're readable, but kind'a weak" signal reports, I returned to the junk box, this time for parts to build a linear. From among the assorted trivia were unearthed a handful of 4x150's. Two hundred watts output at least–a very good tube for the new amplifier–but I didn't have any sockets for them. Being a little impatient to get started, and adventurous at heart, I elected to build the sockets rather than wait out an order from a supply house.

A simple modification of a regular octal socket provided a new base. A ceramic type (for its low losses) was selected. Then all the metal pins were carefully removed from the collar. The pins are crimped to make firm connections with the new size pins of the 4x150, and then are replaced back into the socket.

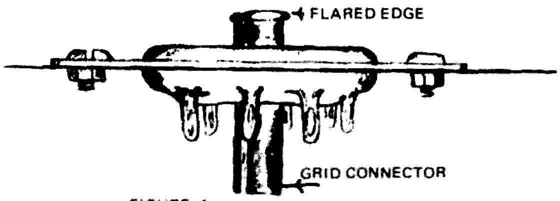


FIGURE 1

A grid connector was made by flaring the top of a semi-circle of sheet metal about 1½ inches high *(Fig. 1).* This connector was placed into the socket key so that the gap between the semi-circle lines up with the slot in the key of the base. To prevent the connector from slipping out again, solder was melted about it, on the underside of the new tube base *(Fig. 2).* For cooling, the tubes were placed almost directly in the mouth of a large squirrel cage blower.

I originally had used only a single .01 μF capacitor soldered directly at the socket pin as the screen by-pass. The rig took off, so to speak, in a very unstable fashion, so small straps on a standoff insulator with another .01 μF capacitor was put above the chassis to by-pass the tube's screen ring. This cured the trouble *(Fig. 2).*

Cooling never figured as a problem. At 50 MHz with inputs reaching 600 watts, a single 200 cfm blower has kept a pair of one-fifties running cucumber cool. Not so many "kind'a weak" reports now.

...WA3AQS

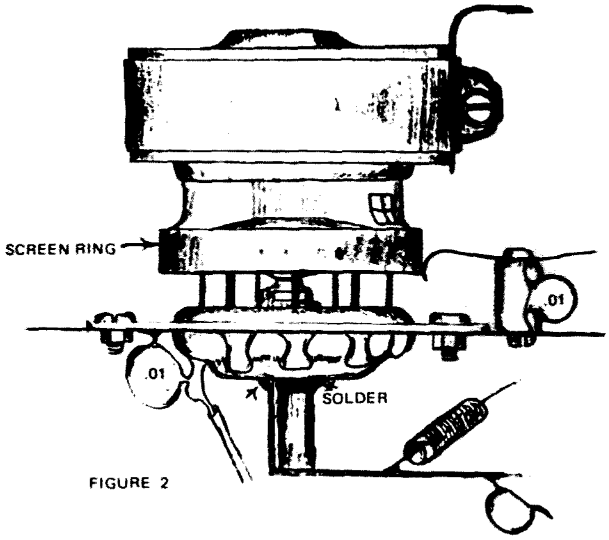


FIGURE 2

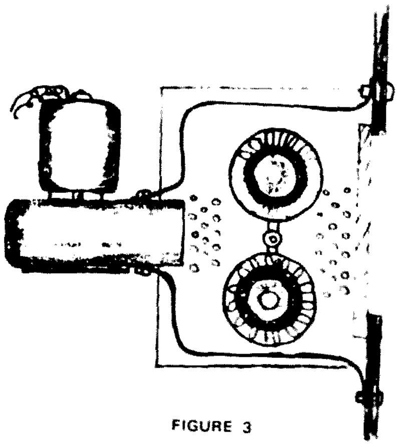
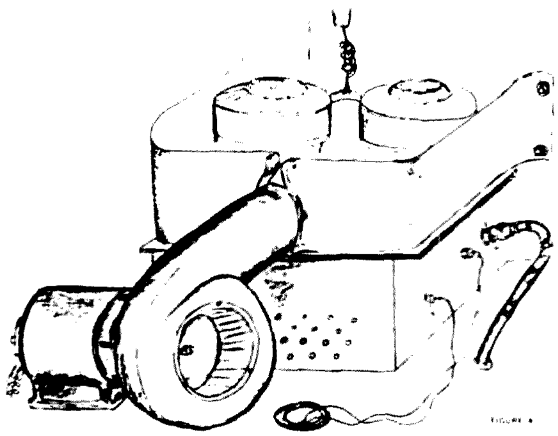


FIGURE 3



RF Sealing Tape

RF sealing is one of the strategies employed in building transmitters that do not generate TVI. The unwanted *rf* is generated but the enclosure is designed so it never gets out.

The same approach is used to build receivers that do not respond to any *rf* except that which enters the receiver through a coax connector, and in the construction of laboratory signal generators.

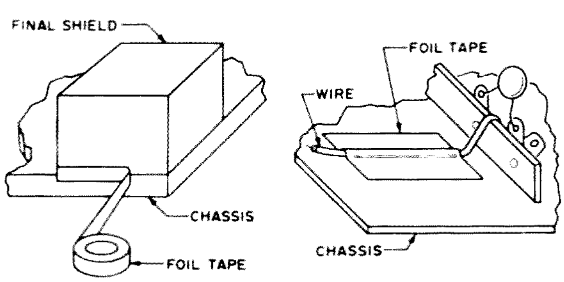
But did you ever try to convert a non-shielded enclosure into a shielded enclosure? It can be done, but ;ften it is a task to make strong men weep. Hinges, joints, ventilation, doors, meters, . . . and how about shielding some of the wiring that carries power through areas hot at *rf*?

Scotch Rescue

The 3M Company has developed a remarkable copper foil tape with an electrically conductive pressure sensitive adhesive. The tape adheres directly to clean metal with a good low resistance electrical connection between metal and copper foil. The tape can improve leaky shielding by up to 60 dB. It is designated "Scotch" Brand Electrical Tape No. X-1181 and comes in 54 foot rolls of assorted widths.

The tape is used alone, or with perforated or solid aluminum sheet. The sheet is available in most hardware stores. It is cut into sections, shaped to fit, and taped in place. Large shielding assemblies can be made up from smaller ones. You must wash the aluminum with detergent to get any oils off before taping.

One approach to reducing *rf* pickup by power or control wiring in transmitters is to use shielded wire. This is horrid stuff to work with, if you have ever tried it. A piece of ordinary hookup wire can be laid along the chassis and covered with a strip of shield tape, to achieve the same result.



Donald Kerr, WA3BDI
State College, Pennsylvania

Alan Shawsmith, VK4SS
35 Whynot St. West End
Brisbane, Queensland, Australia

An All Band Curtain Array

1.75 to 30 MHz

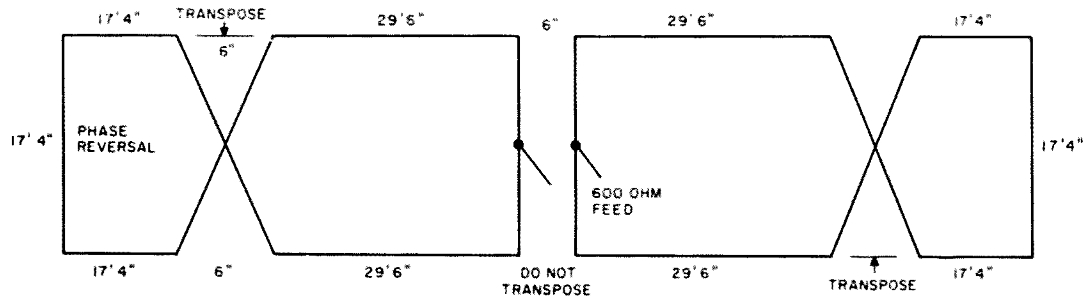


Fig. 1. Dimensions for the all band curtain array.

Looking for something better than a random length flat top for your multi-band operation? This pint sized array which puts out a big signal should more than provide the answer. After some cut and try trials, the configuration shown in **Fig. 1** was decided upon as the best all band result. It represents an attempt to get the *most* with the least outlay. All that is required over a flattop is some extra wire and insulators. It should be easily erected on any average lot, as the total length between poles is approximately 112 feet. It has superior gain over most flat-tops on 14, 21, and 28 MHz. Its low angle of radiation being one feature. If it is not possible to erect it to its full length, the 8 foot spacing at the transposed sections can be reduced somewhat with slightly less gain available.

On 1.75, and 7 MHz respectively, it really performs as a quarter, half, and 2 half waves in phase. However, the configuration at 7 MHz does add some gain and lower the angle of radiation slightly. If DX is desired on these bands, the bottom wire must be at least 30 feet above ground and preferably much more. For DX on 14 through 28 MHz the bottom wire should be a minimum of 20 feet above earth. On 28 MHz, there are some 8 wavelengths of wire up in space which adds to the signal.

Maximum radiation is mainly broadside on bands 1.75 through 21 MHz. It throws the sharpest beam with the most gain on the latter band, while on 14 MHz, the pattern is broad and something in shape like a three leaf clover on either side of the axis. No db measurements have been attempted, but its performance is far superior to a random length wire used at the same QTH and strung at a comparable height. Since it is horizontally polarized, the higher the array is strung up, the better.

Being multi-band, no attempt can be made to match the 600 ohm feedline, which can be any length, but may have to be pruned if the array is reticent to accept power on any one band. A flexible all band antenna tuner is a must for proper loading.

...VK4SS

A. E. McGee, Jr., K5LLI
2815 Materhorn Drive
Dallas, Texas 75228

How To Tune A Circuit

In these days of intricate and relatively inexpensive commercial radio equipment, home building of ham gear is not so common as it used to be. However, a great deal of pleasure and satisfaction may still be had from the designing and building of simple receivers, converters, etc., even if you never intend to actually use them on the air.

One fairly critical part of most simple projects is the tuning circuit. At frequencies through the VHF region, a tuning circuit usually consists of an inductor (coil) and a variable capacitor, which is adjustable over a reasonably wide range. It is easy to find, by the trial and error method, some combination of inductance and capacitance that will tune to the desired frequency. The trouble usually begins when you try to band-spread the circuit; that is, to make the entire tuning range of the variable capacitor cover only the desired frequency range. This frequency range may be only several hundred kilohertz wide, such as an amateur band or a shortwave broadcast band.

This article will attempt to illustrate the problems involved, and how to solve them by the use of a grid-dip oscillator and some simple charts and formulas. First, however, a few words about circuit theory may be in order.

An inductor or a capacitor will oppose the flow of an alternating current. This property is called reactance, and differs from resistance in that the current through the reactance is 90 degrees (or one-quarter cycle) out of phase with the voltage. In an inductor the current lags the voltage by 90 degrees, and in a capacitor the current leads the voltage by 90 degrees. The amount of reactance is determined by the value of inductance or capacitance, and by the frequency of the alternating current. Inductive reactance increases with an increase in frequency, while capacitive reactance decreases with an increase in frequency.

When an inductor and a capacitor are connected, either in series or parallel, there will be one frequency at which their reactances are equal. Since the inductive reactance causes a current lag of 90 degrees, and the capacitive reactance causes a current lead

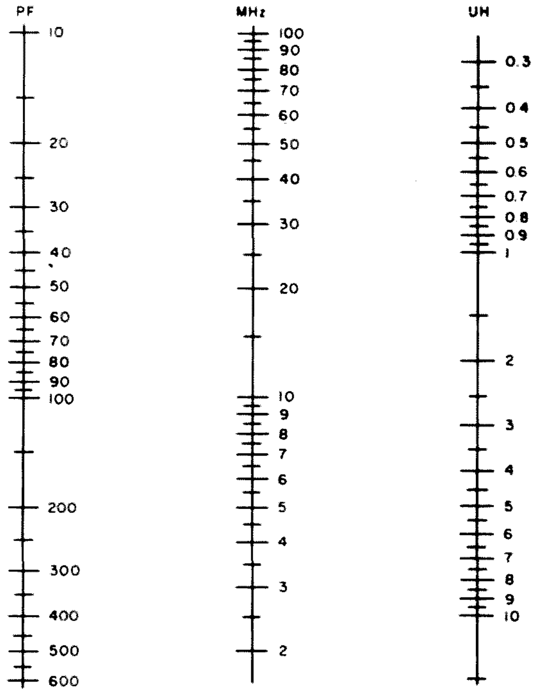


Fig. 1. Resonant frequency chart. By laying a straight edge across two known quantities, the third can be determined.

of 90 degrees, the reactances cancel each other, and the circuit is said to be in resonance. The series resonant circuit offers a very low resistance to the flow of alternating current at the resonant frequency, and the parallel resonant circuit offers a very high resistance to the flow of alternating current at the resonant frequency.

The frequency of resonance may be found by using the formula: $f = \frac{1}{2\pi\sqrt{lc}}$ with f in Hertz, L in Henrys, and C in Farads. A simpler method is to use a chart like the one in Fig. 1. By laying a straight edge across two known values, the other quantity may easily be found. Charts covering a wide frequency range may be found in Allied's Electronic Data Handbook and other similar publications. There is also a chart on page 70 of the August 1967 issue of 73 Magazine.

Let us say that you wish to build a circuit that tunes from 7.0 MHz to 7.3 MHz. You have a variable capacitor from the junk box that you wish to use, a few surplus coils with unknown inductance values, and an assortment of small fixed capacitors. You also must have a calibrated grid-dip oscillator.

In order to find the capacitance of the variable capacitor, you will first need a known value of inductance. Pick a likely-looking coil from the junk box, or wind one by guess or by using a coil winding chart. The chart found in Allied's Electronic Data

Handbook is easy to use and accurate for coil diameters from ½ inch to 5 inches. Connect a fixed capacitor with a known (marked) value across the coil and find the resonant frequency of the combination with the grid-dip oscillator. If possible, use a mica capacitor with a 5% or 10% tolerance. Let's say you use a 100 pF capacitor and the resonant frequency is 9.2 MHz. By laying a straight edge across these two values on a resonance chart (**Fig. 1**), the inductance of the coil is found to be 3 uH.

The 3 uH coil may now be used to measure the minimum and maximum capacity of the variable capacitor. Connect the coil across the variable capacitor and measure the resonant frequency at the minimum and maximum capacitance settings. If the resonant frequency is 20 MHz at the minimum setting and 5 MHz at the maximum setting, the variable capacitor has a range of about 22 pF to 350 pF.

You will note that the frequency ratio (4 to 1) is equal to the square-root of the capacity ratio (16 to 1). This is important to remember, and is true also for the inductance ratio when the capacity is held constant. Thus, in the circuit above, if it were desired to bring the lowest frequency down from 5 MHz to 2.5 MHz, a 2 to 1 frequency ratio, the capacity or inductance would have to be increased by 2 squared, or 4 times (1400 pF with 3 uH, or 12 uH with 350 pF).

Now that the variable capacitor has been measured, a coil can be chosen that will tune the desired 7.0 to 7.3 MHz range. It may be seen, by checking our resonance chart, that the 3 uH coil used in measuring the variable capacitor will tune to 7.0 MHz with about 175 pF, and to 7.3 MHz with about 160 pF. As this is well within the range of our variable capacitor, we may as well use it in our circuit.

Band-Spreading

Although our circuit will tune through the range of 7.0 to 7.3 MHz, the required capacity change of 15 pF would be covered in only a small fraction of a turn of the capacitor, and tuning would be very difficult. This problem is easy to solve, however, by the addition of two more capacitors to the circuit. Since we need a variable capacitor with a range of 160 pF to 175 pF, a capacitor may be added in series with the variable to lower the total maximum capacitance from 350 pF to 175 pF, and a capacitor may be added in parallel with these two to raise the minimum capacitance from 22 pF to 160 pF. See Fig. 2. The series capacitor is called a padder and the parallel capacitor is called a trimmer.

The value of the trimmer should be determined first. Its approximate value can be found by subtracting the minimum capacitance of the variable from the desired minimum capacitance. Thus 160 pF minus 22 pF equals 138 pF for the trimmer. The value of the series combination of the variable at maximum capacitance and the padder is equal to the total desired maximum capacitance minus the trimmer capacitance. Therefore 175 pF minus 138 pF equals 37 pF for the combination of the variable (set at 350 pF) and the padder. The value of the padder may be found by the formula: Cl=CtC2/C2-Ct, where CI is the padder, C2 is the variable, and Ct is the desired total. This works out to 41 pF for the padder.

Since the padder is only about twice the value of the minimum capacitance of the variable, it will have a noticeable affect on the total minimum capacitance, making it 152 pF instead of the desired 160 pF. This difference will be more than made up for, however, when other parts of the circuit are connected to the tuned circuit. Stray circuit capacitance and the input or output capacitance of the tube or transistor used will add from 5 to 10 pF or more to the total capacitance. At the higher frequencies this becomes increasingly important, and should be allowed for.

When building a circuit one stage at a time, remember that when the following stage is connected it will upset the output tuning of the previous stage. It may be helpful to connect a small value of capacitance temporarily across a tuned circuit that will later be connected to another stage. When the other stage is connected you can remove the capacitor. At high frequencies, where the adjustment range may be small, this may keep you from having to rewind the coil.

A good type of capacitor to use for trimmers and padders is the adjustable mica

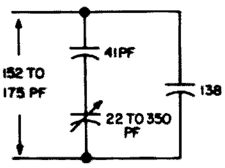
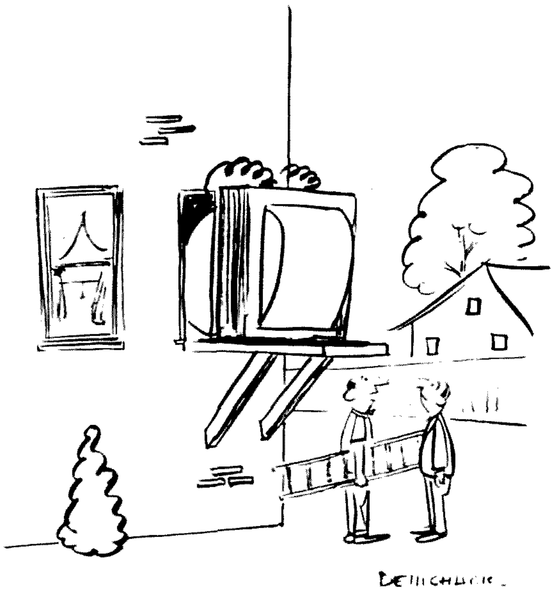


Fig. 2. The 22 to 350 pf variable capacitor is effectively changed to 152 to 175 pf by the addition of two extra capacitors.



"I added a linear."

compression type. These are small and inexpensive, and come in sizes ranging from about 1 pF to over 3000 pF. The minimum to maximum capacitance ratios vary from about 10 to 1 in the small sizes to about 2 to 1 in the largest sizes. When using adjustable capacitors set the high frequency limit with the trimmer, and the low frequency limit with the padder. Since the adjustments affect one another they may have to be repeated several times. If maximum stability is important, fixed silver mica or adjustable air capacitors should be used.

I have not mentioned circuit Q. This quantity is important in the output circuit of transmitters, in circuits where maximum selectivity is important, and many other places. However, in most simple low-power circuits the Q may be safely ignored.

. . . K5LLI

SSB Escalator – Part II

Since the original article on *rf* SSB speech clipping appeared in 73 Magazine (p. 16, Dec., '66), I have received a number of inquiries relative to the construction of the clipper unit.

Resistors R3 and R4 in *Fig. 1* should be interchanged (this was a printer's error). Replace the 300Ω cathode resistor of V2 with one of 68Ω and the 47k screen resistor with one of 20k. At the grid input of V1 the 22k resistor is omitted and a 140 pF APC variable capacitor is substituted for the fixed 180 pF condenser for maximum tuning of the signal. Mount the mechanical filter topside with its midpoint baffle shield omitted—an original but later-proved unnecessary precaution.

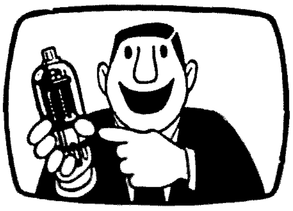
It is important that the filter employed be identical to the one in the exciter unit. If the carrier frequency is not down on the filter skirt at or very close to that in the exciter unit, one of two undesirable things will take place: either the lower voice frequencies will be out of range of the passband and the audio will sound tinny, or insufficient sideband rejection of the lower clipped voice frequencies will occur with unwanted, newly generated frequencies. It may be preferable to extract the *rf* signal at the output of the balanced modulator rather than at the output of the following *if* stage. In place of the original Millen *if* transformer, T1, try a less expensive one; T2 may be a Miller 912-C4 *if* transformer. The .01 mfd coupling condenser in the secondary lead of T2 may be left out.

The power supply can be placed on the same chassis with the clipper unit although a larger chassis, of course, will be required. Any power supply system that will deliver from 30 to 50 mA at a regulated voltage of 105 to 150V will be satisfactory.

The following simplifications may be made: Omit the sub-miniature switch, S1, and run the two RG-174/U coax input and output leads directly to the two jacks mentioned in the paper. A short coax-cabled jumper between the two jacks will restore the original exciter operation. Omit both the no-clip gain control and the DPDT switch, S2. Simply rely on the clip level control to adjust the amount of *rf* clipping.

If excessive hum is encountered when clipping, it may, unfortunately, be necessary to shield the exciter's audio input stage.

Louis Berman, K6BW



NEW PRODUCTS

HEATHKIT
2 Meter Transceiver
Model HW-17

Heath 2 Meter Transceiver

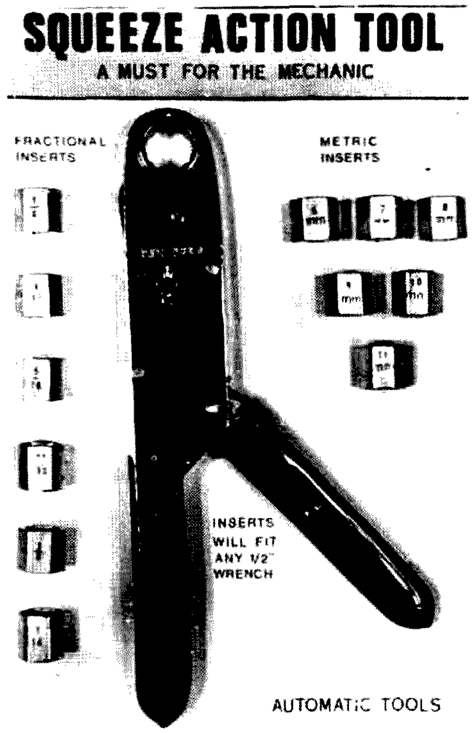
The latest in a growing line of "single banders" has come out of the Heath Company. This new unit, the model HW-17, covers the amateur two meter band and also has facilities for the MARS and CAP frequencies. Crystal controlled, the output is about 10 watts AM.

The dual-conversion solid state receiver has 1 microvolt sensitivity and features a prealigned FET tuner, ANL, Squelch, "Spot" function, lighted dial and a relative power output meter. It comes with a built-in AC power supply and microphone. The DC supply for mobile operation is optional at $24.95. Priced at $129.95, this is a best buy item. For further information, write Heath Company, Benton Harbor, Michigan 49022.

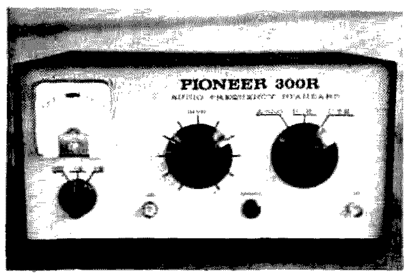
SQUEEZE ACTION RATCHET WRENCH

Fulfills the requirements of professional and home mechanics. In hard to reach areas, turning is accomplished by merely squeezing spring loaded scissor type handle. Where there is more room it can be operated like a conventional ratcheting box wrench. For reverse action, just turn the tool over. Box socket is ½". Twelve hex inserts range from ¼" thru 9/16" and millimeters from 6 mm thru 11 mm. A rubber friction lock keeps the insert firmly in position. Retail $12.95.

For further information contact THE JAY THOMAS COMPANY, 117 West Oxford Street, Dept. M.M.-5, Chula Vista, California 92011.



Pioneer 300R Audio Frequency Standard



The Pioneer 300R is a highly stable seconcary frequency standard of completely solid state design, using quartz resonators for stability. It functions as a tone receiver or tone transmitter. The stability is .005% and switching allows selection of up to three standard frequencies. It provides a built-in attenuator for receive applications.

It can be used in the receive mode for calibrating oscillators directly without the use of an oscilloscope or other indicating device normally needed with a standard to indicate zero beat. It is an indispensable piece of equipment for RTTY, and a valuable calibrator for oscillators, oscilloscopes, and bridges. Accurate inductance and capacitance measurements can be made using this precision source. To guarantee stability over a wide range of temperatures, the resonators are kept at a nearly constant temperature in an insulated and shielded oven. The oven comes as a sealed unit with desired resonators included

inside. Additional frequencies may be obtained for $35 each.

For further information write Pioneer Electronics, 738 Pacific St., San Luis Obispo, California 93401.

Linear Systems, Inc.

David C. Thompson, President of Linear Systems, Inc., has announced the election of David K. Bradley as Vice President, Marketing for the firm. Mr. Bradley previously was National Sales Manager for the SBE line of amateur radio products at Raytheon Company, South San Francisco, California. He has been active on several EIA committees in the amateur and citizens band business. Mr. Bradley is well known in the amateur radio fraternity and has the amateur license W6CUB. Prior to joining Raytheon, Mr. Bradley owned and operated an amateur radio distributorship in Northern California. Mr. Thompson stated that Mr. Bradley brings a unique combination of technical and marketing experience to the company. This capability fits the needs of Linear Systems, Inc., which Mr. Thompson stated plans to become a broad based communications company.

Optiflex

Fiber optics is that light-piping idea you have been reading about sometimes over the past few years. IBM uses fiber optic devices to pipe light to convenient corners of their card-reading machines, eliminating many individual lamp assemblies. Now the idea is appearing in service gear.

Amertest Products' handy little lamp consists of a conventional penlight plus a flexible fiber optic cable. The cable really is flexible enough to tie into knots. It's a nonconductor, too, so that you can poke it into live circuits and assemblies without concern about new unwanted connections inside the gear or out to the real world, including yourself. Just right for getting some light into those dark corners.

Suggested list price on the Optiflex lamp is $4.65. For additional data inquire at your dealer's, or write to Amertest Products Corp., 144-27 Jamaica Ave., Jamaica, L.I., N.Y. 11435.

AMD Microphone

If you are interested in outdoor amateur operating, serious on-location tape recording, in speech work, or public speaking applications, here is a microphone that may well be a Best Buy.

Since it is a cardioid microphone it has a strong null toward the cable-attachment end. This avoids crowd noise problems, and greatly alleviates the nuisance of audio feedback in public address applications.

For outdoor tape recording and amateur operating, its built-in windscreen styling reduces or eliminates the need for the frequently-seen large plastic foam cover. And the microphone's 100 to 12,000 Hz response is adequate for all speech and some musical applications.

Special connector wiring in the microphone stem offers the user a choice of 600 ohm impedance (-73 db sensitivity) or 50K ohm impedance (-54 db sensitivity.) It has an on-off switch, and comes with 20 feet of cable with a standard phone plug, and a swivel microphone stand connector.

Priced at $13.95 retail, from AMD Electronics, 663 Dowd Ave., Elizabeth, N.J. 07201.

FCC Recognizes Thailand—Almost

The FCC has announced that it is now permissable to contact stations in Thailand using U.S. calls/HS. Communications are still prohibited with the HS prefix stations.

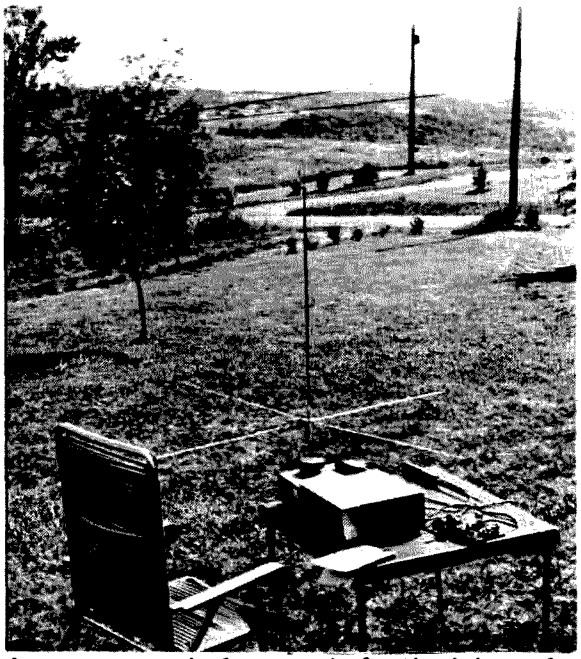
Adapting A Mobile Antenna System for Vacation Use

Bud Michaels, WB2WYO
510 High Street
Victor, New York 14564

A last-minute decision to take a rig along on vacation left me with the problem of what to use for an antenna. We would be moving from campsite to campsite every few days, so my inherent laziness precluded an elaborate antenna system. Likewise, I didn't have much enthusiasm for disturbing three years' accummulation of rust and crud to dismantle a mobile whip antenna, offered by a friend, along with a complete set of resonators.

After much consideration, the mobile system seemed the most practical, and I accepted the loan of the resonators, but struck out on my own to devise a whip and base; one that would allow me to use the resonators, yet not necessitate tying the car down at the campsite.

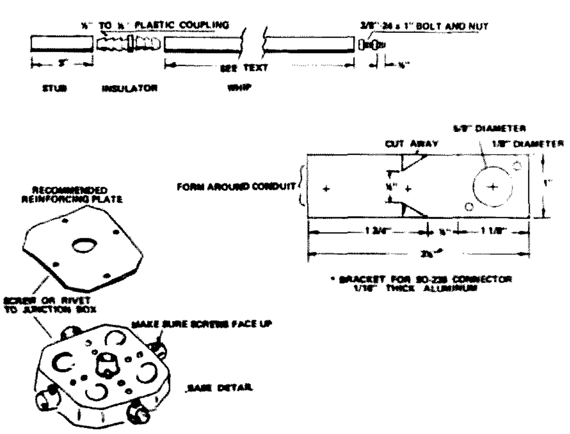
The problem was solved using EMT electrical conduit. A whip, base and supports/radials were made using ½" diameter conduit and a square junction box. The whole affair cost less than $5.00 and proved to be a truly effective and simple antenna system. In fact, I'm collecting my own set of resonators in anticipation of next year's vacation.



Antenna set up in front yard of author's home for SWR measurements. Additional ground was required for 40-meter operation.

Making the Whip

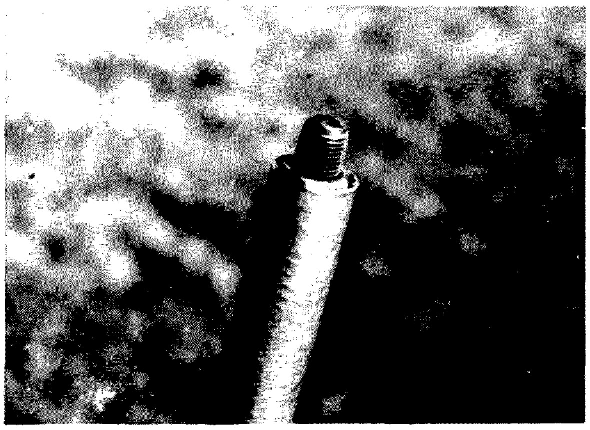
Cut a piece of ½" diameter conduit to 54". (This dimension is for Newtronics resonators. For other resonators, rely on manufacturer's specs or measure a friend's antenna.) A pipe cutter does a neater and faster job than a hacksaw. File away the burrs at both ends, then brighten up the metal inside one end of the conduit so it will take solder.



File the edges off the head of a 3/8"–24x 1" bolt, and a 3/8"–24 nut so they will fit snugly into the conduit. Thread the nut onto the bolt, leaving ½" of the bolt extending. Tin the bolt and nut, then slip them into the conduit with the nut flush with the end of the conduit. Solder them in place. This forms the means of attaching the resonators to the whip.

The whip must be insulated from the base. This is done using a ½" to ½" plastic water pipe coupling. Cut a short piece of conduit, around three inches long. Clamp this in a vise and warm with a torch until you can force the plastic coupling in. Quickly cool the assembly, lest the heat distort the coupling. Do the same with the bottom of the whip, so when finished you have the plastic coupling (our "insulator") between the whip and stub. The plastic coupling will most likely slip out of the conduit, and epoxy cement or "pop" rivets can be used to make the joint more permanent.

I found it more convenient to attach an SO-239 connector so that the coax cable could be more easily connected. Details are given for making a bracket to mount the connector. (Naturally, this idea came *after* vaca-



End view of whip showing the 3/8-24 bolt which screws into mobile-antenna resonators.

tion!) The center wire from the connector is soldered to the conduit through a hole made for the purpose. If you do not wish to use a connector, the coax can be soldered directly to the whip; the shield being soldered to the stub.

Base

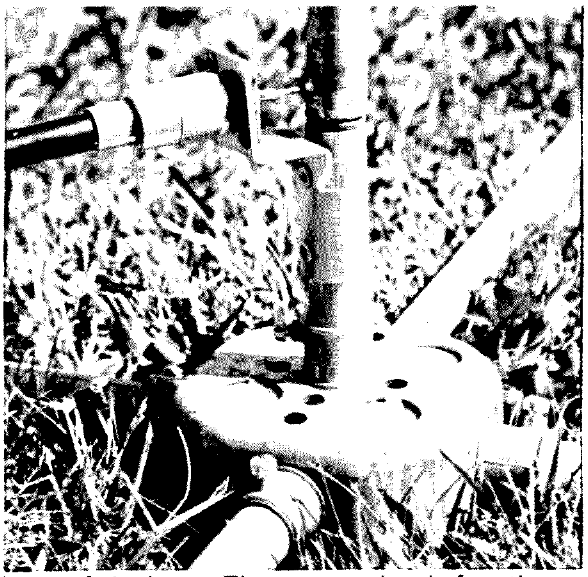
The base is made from a 4" square electrical junction box. Be sure to use one with ½" knockouts. Five ½" conduit connectors are screwed into the knockout holes, as shown, with their screw heads facing upwards. Don't overlook this simple point, otherwise, it will be awkward to disassemble the antenna for take-down. Here's another bit of hindsight: the top of the junction box is not too sturdy, owing to the knockouts stamped in the metal. Make a plate to fit over the top, as shown in the illustration. Screw or rivet this reinforcing plate to the box, then install the center connector. You will find this arrangement holds up much better, especially if you anticipate small boys will be using your antenna for a "Maypole."

Support—Radials

The four supports/radials are made from five foot lengths of conduit. Five feet is a convenient length to carry, and two can be cut from one 10-foot length of conduit (standard length). Don't make them any shorter, or mechanical stability and antenna radiation will suffer. If you can make them longer, so much the better; especially if you intend doing any work on the 80 and 40 meter bands.

Setting Up

Using the antenna system is simplicity itself. Place the four radials into the connectors and tighten the screws securely, yet not enough to deform the conduit. Attach the whip to the center connector, then screw the resonator to the top of the whip. Follow the manufacturer's instructions for adjusting the resonator to the lowest swr. I did have trouble bringing the swr down on the 75 meter resonator, due to poor ground conditions. (After all, five foot long radials at 75 meters is a joke!) The problem was relieved somewhat following a suggestion by WA2AOD: use kitchen aluminum foil swiped from the XYL to increase the ground plane. Four 15' long strips placed under the radials helped get my signal out with acceptable performance.



View of the base. These were taken before the reinforcing plate, mentioned in the text, was added. Coax bracket is held to base with "pop" rivets.

Some Other Ideas

The success of this arrangement prompted me to do some experimenting after we returned home. Using the same base, I made an 18' vertical antenna using one 10' section of conduit, joined with a regular ½"-to-½" coupling. The antenna was base loaded with a coil. While the junction of the two lengths of conduit was not the strongest, I did manage to keep the antenna up all weekend and worked quite a few stations on 80 and 40 meter CW. (This, by the way, was done after the junction box top was reinforced as described above.) As a practical limit, it seems that 20' is the maximum height for conduit "verticals" because of the lack of rigidity at the joints. If you could come up with a stronger joint, I imagine these might serve admirably for field day use, with a minimum of guying.

...WB2WYO

LETTERS

This is in response to your letter of February 19, 1969, concerning the implementation of the second phase of the incentive licensing frequency reservations. In establishing the time schedule for the reservations of frequencies in Docket 15928, the Commission states that "Notwithstanding this schedule, the Commission intends careful review and if it is determined that there is insufficient occupancy of any part of the reserved frequency segments, then the effective date of the implementation date will necessarily be stayed in whole or in part, as appropriate." This statement has been reiterated in a number of Commission actions since the determination in Docket 15928.

A petition (RM 1393) is on file requesting the Commission to rescind that portion of Docket 15928 which would reserve additional frequencies in the 7 Mc/s and 14 Mc/s bands for Extra Class licensees. As previously stated, the Commission will review the occupancy of the segments now reserved and determine, prior to the November 22, 1969, scheduled date for implementation of the second frequency reservation, whether additional reservations are justified.

James E. Barr
Chief, Safety and Special Radio Services Bureau
F.C.C.

Say Wayne, I just picked up 73 and liked very much your thoughts on incentive licensing. Your positive approach to this and other matters merits careful attention. I also, of course, note your continuing license study articles, which are by far the best that have appeared in ham publications. I have been helping some hams with some of the basics for their licenses (I hope) and your articles have saved me some time of having to go into Terman or the ARRL handbook, etc. Thanks to you and your staff for publishing these articles and not just questions and answers as have some of the other magazines.

Incidently, you mention other mags saying things about 73; yes, I have read these and started adding certain things up; in fact, I went back several years in the various ham magazines and read about what is and was going on. You are right and they are wrong. Say, Wayne, do tell us all about the IARU, CQ, and other things that the amateurs are anxiously waiting to hear about. Don't be too harsh on the ARRL though, they are trying to do a good job handling all that traffic and keeping the nets on frequency and holding elections and partitioning the FCC and stuff like that there.

Bob, W7JLU
Portland, Oregon

I consider 73 to be one of the finest magazines in the amateur radio field, or indeed, in any field. This is about the fourth year I have been reading 73 regularly and I have thoroughly enjoyed each and every issue.

In comparison to the technistic platitude that is QST and the artistic mediocrity that is CQ, 73, like the farmer, is outstanding in its field. You have managed to keep a sense of humor throughout these times of peril for amateur radio in general. This is certainly a relief from the competition who feel that they can be dry and serious for 11 months out of the year if they make it up with a whopping April issue.

In summary, then, I think 73 is the greatest, and I sincerely hope it can stay that way for many years to come. Above all, I can only hope and pray that your idea that ham radio is *fun* will have a rebirth among the electronistic and scientistic types who've pervaded the radiophonic world recently. My amateur Extra Class license notwithstanding, I'd rather chew the rag about music, girls, politics, or UFO's than build my own self-neutralized class AB_2 variable-preble amplifier module with limited-fidelity sideband autonizer.

Lon J. Berman, WB2IWI/2

Open Letter

If you did not read Wayne Green's excellent editorial in March 73 Magazine, you should have! It was timely, pointed and full of meat!

Amateur Radio greatly needs the shot in the arm that a well-conducted Public Relations program could give—provided that the PR people are properly "Amateur-Radio-oriented!" ARRL desperately needs a better image with the Radio Amateur, with the public and most of all with the U.S. Government, to whom we owe our very existence—and continuence!

Wayne mentioned certain writers and a cartoonist who could help. There are many qualified writers in the field who could and would contribute articles and material to this endeavor, given the slightest opportunity—and acceptance by editors.

The capable Ray Meyers, W6MLZ, it has been reported, offered to serve ARRL as its PR man, for the customary $1 a year, plus normal operating expenses. Ray's qualifications need not be discussed here—they are completely adequate, and his devotion to Amateur Radio is well known through many years of dedicated service as a writer, lecturer, Director of ARRL, and columnist. Ray's generous offer was spurned by ARRL. Why?

ARRL's feeble attempts at PR have been through NON-licensed-Amateur personnel. Although Don Waters did a commendable job on his reporting of ARRL's status—it lacked the touch of a genuine Amateur, fighting for his own hobby.

This writer urges YOU to immediately contact your ARRL Director, by telephone or mail, and demand that ARRL institute a program of PR, with a "man in Washington" (a legalized ham-lobbyist) without delay. Let there be no referral to a committee or a "study by the Secretary to determine the need" or other typical procedural jazz by the ARRL Board. Demand that the Directors, at this meeting, set up such a program and that they follow through to see that it is done. As Green says, it may already be too late, but the effort must be made. Take action now!

In reference to Wayne Green's mention of band

occupancy, a complete study should be made, by ARRL (or someone concerned with the progress and growth of Amateur Radio) to determine what changes are necessary and vital in regard to band usage. In the opinion of this writer, (a consistently active ham for 49 hears) the CW bands are loaded when contests are on–and pretty empty at other times. The VHF bands are consistently empty, except during "openings" or contests. Ten meters, formerly the work horse of casual rag chewers, shows little occupancy now. Such an occupancy study, plus recommendations, both *qualified* and *studied*–to FCC–should result in changes, even though temporary, that would raise the occupancy of our empty bands segments and reduce the QRM in the other sections.

There is nothing sacred about FCC regulations. They can and should be changed when the need arises and without long delays, hearings and other proceedings.

ARRL should have a better relationship with FCC and be able to advise FCC when and how the band segments should be changed and redeployed! No one is served by holding to long usage concepts of the bands when it is obvious to any active ham that changes are desperately needed.

On this point, why are so many licensees who are now permitted to utilize the "restricted" segments, still holding forth in the cluttered-up sections?

A. David Middelton, W7ZC
Former ARRL Director

With reference to certain aspects of the "de W2NSD/1" article in your March issue, you may be interested in the following information.

In the April 1967 QST, there appeared a request that members advise their Directors with respect to their opinions on (1) dues; (2) freeloaders; (3) docket 15928; (4) by-laws; (5) CB liaison. I wrote my Director, Gil Crossley, and sent copies to the then Vice-Director and to Harry Dannals, Hudson Division Director, since I had a permanent QTH at my boyhood home in that area.

My letter, in part, read: "Final item–amateur radio must have adequate representation in Washington. Maybe "lobby" is a nasty word to some, but it is a recognized procedure. We desperately need it, both for our protection and advancement. I spent many years in Washington as an industrial representative, and I know how much the right word in the right ear at the right time can accomplish. Please have this considered."

I had no reply from either Harry or the V-D, at that time W3KT, but I received a very nice note from Gil, which read, in part: "Relative to representation in Washington–that is very well taken care of, with amateurs in the different departments of the government and legislative halls. What I am saying is not generally taken by many amateurs but things can't happen without our knowing it at once. I certainly felt the same before I was on the Board. For example, Bob Booth our legal advisor is president of the legal organization that practices before the FCC. To have a so-called lobby, it would have to be registered and we would likely lose our tax exempt statis." (Sic)

Now, it seems to me that he simply does not understand what a lobbyist does, in the sense of the scope of the job beyond collection of information. So, I wonder if the other Directors may not likewise lack that understanding? If so, how can the question possibly receive adequate consideration?

Also, I thought that the tax-exemption matter might be of interest to you. In any event, I don't recall that "lobbying," in any context, was considered at the subsequent Board of Directors meeting.

Al Smith, W2AFJ/K3ZMS
Doylestown, Pennsylvania

Like you say, the rush to Extra Class doesn't seem to have materialized; this is going to crowd hell out of the segments assigned to General Class. I have talked with holders of Extra Class tickets and they tell me that most, if not all, their cronies are General Class; therefore, they will be using the upper segments in order to chat with them. This is going to give our friend, Chop Chop, a chance to say the Extra Class segments are not being utilized to any great extent, so, like 11 meters, we may expect to lose that portion of the band to other services. Those Extra Class tickets should have been allowed to use a part of the CW portion for phone. Then, maybe there would have been a bit more incentive, nicht wahr?

Bert Berthelsen, W5IOI
Ormond Beach, Florida

I appreciate the FB job on your Advanced theory articles—and now the Extra. *Many tnx!*

Guys older in years (but not old timers in Ham Radio) such as myself, need this stuff interpreted and written as you are doing.

Bill, WA8AME
(Now Advanced Class!)

73 is excellent, no rubbishy padding (i.e., DX reports). Please keep up the good work! Over in the U.K., we find it very difficult to find *practical* articles on the advanced semi-conductor devices, i.e., I.C.'s and FET's etc., so your really great articles are appreciated. A couple of years ago, I subscribed to QST, but in one full year, I personally found only one article (on Ferrite Toroids) of real value, and needless to say, you had already covered them (and better) six months earlier!! Yes! I guess I'm sold on 73.

73 and all the best for 1969.

Chas, 93RNV
Cheshire, England

I first went on the air with the call 2-KJ in Brooklyn, N.Y., in 1919, and have been on and off ever since. In almost fifty-years of ham activity, I have never encountered a situation such as now exists in Phoenix, Arizona, on the twenty meter band, approximately 14.340 MHz.

Time after time, I have heard K7GRU come on and create what appears to be deliberate interference. Very often he interferes with the operation of the Coast Guard Net trying to run overseas welfare traffic; he indulges in invective and name calling. He settles down on QSO's in progress and talks of his technical excellence and the efficiency of his equipment yet his signal is often ten kHz wide. There is more but this is enough to give you my thoughts on the matter. If anyone ever tried to give amateur radio a bad name, it is he.

A. R. Taylor, WA5WMJ
Gravette, Arkansas

Every project that I have built from "73" Magazine has worked the first time. Can't say the same for any other magazine. The best one of all was "A Beginner's Receiver," 73 June 1963.

I would also like to see a BC-454 or BC-455 conversion to 14 MHz to 17 MHz or 15 MHz to 18 MHz. Maybe some reader would forward his conversion to me?

I believe you have the best magazine going. Maybe Playboy is better, but they don't have too many radio articles.

Dick Heydt
P.O. Box 222
East Granby, Conn. 06026

Just a word of appreciation for the series on the Advanced Class. Recently a friend of mine called to say that he was going to Kansas City in about a week to try for the Extra license and suggested that I go along and try for the Advanced. I did an intensive study using the series from 73 and passed with few errors. The series was interesting, (unusual for such a technical subject) well-written, and very practical. I am looking forward to the Extra Class series.

Horton Presley, K0HVK
Ottawa, Kansas

73 came in late this month and I miss the letters from your readers.

I believe your graphs showing the negative results of incentive licensing only proves my contention that the majority of US amateurs do not approve of this and are not going to support it. They feel as I do, the only way now to defeat it is to ignore it and the FCC will in the near future rescind it.

They know it was instigated by a small selfish group that had undue influence with the FCC through the ARRL for the express purpose of giving themselves an advantage of QRM free operating frequencies.

The vast majority of amateurs that have carefully thought this issue out know that passing the advanced and extra class exams will not accomplish any better operating practices or will it clean up the violations being practiced on our bands. So it has no useful purpose.

You have the wrong attitude Wayne. Laws can be changed—remember prohibition?

The FCC said they would review the problem after it had been in use and would if the frequencies were not used sufficiently rescind it. Certainly only 6000 amateurs out of a quarter of a million does not constitute a sufficient number to justify any special frequencies assigned to them. So the majority of amateurs have in my opinion decided this was unjustly forced upon them and that the only way now to defeat it is to resign from the ARRL and refuse to take the new tests in protest and to hope the FCC will see the mistake they have made.

The FCC has unfairly discriminated against the CW operator. They now make him take the most complex theory tests (both Advanced and Extra) when he is using the simplest of equipment, just to get the full use of the CW frequencies he is or was assigned. I am a CW man.

This irresponsible action of the ARRL has accomplished only one thing and that is it has emphasized to the commercial interests and to the forthcoming convention of frequency allocations that the amateur bands are too large and that the amateur can afford to lose some of his frequencies because the ARRL feels the great majority of amateurs can be forced into a much smaller segment of the bands that we now hold. This is the interpretation the commercial interests will give to this and use it against the amateur frequency assignments.

I was a member of the ARRL back in the early

20's and I knew Percy Maxim personally and I sure liked the old man. He would not have approved this action of the ARRL.

The ARRL knew they had made a mistake after they made this proposal but they were not big enough to admit it and went along with the hope the FCC would have the good sense not to approve it. This was proved by the futile way they have tried to justify and defend it even saying they did it just to create a controversy. How insane has an organization to become before it is committed? They don't have to be, they have committed suicide by themselves—"Give a fool enough rope, etc."

Wayne, for your information, this incentive licensing has done much harm in many ways. I would like to mention a few instances that have come to my attention. I have a local friend that has been a ham for many, many years; he is sixty years old and has been very active in the past in the local radio club, on the TVI committee, etc., and has given many hours of code and theory classes and has many local hams that owe him for their tickets. He has always been a general and is a retired dentist. Well, he went to Miami and took the Extra exam. He passed the CW but failed the theory. This was very embarrassing to him and he has given up completely—I never hear him on the air anymore and he gave me four big boxes of parts and equipment—the contents of his junk box. You see, the ARRL has caused us to lose a very fine amateur. This is just one case I know about, there must be thousands of others that have just given up because of this irresponsible act of the ARRL and the FCC. In the interest of amateur radio, I think you should still fight for the rescinding of this provision that has been forced on us.

One of your arguments can be that amateur radio is truly world-wide and international and that it is unfair to the USA amateurs to be restricted by special examination from use of parts of the bands that other countries do not restrict. Amateur radio is international and the rules should be international—this is only fair play.

For example, this has brought about another problem that of reciprocal licensing. We have here in South Florida a lot of retired Canadian hams that live here permanently but because they are Canadians, have their VE calls and the Ft. Lauderdale, Fla., USA, address in the Canadian call book. Now, with this incentive licensing that they do not have in Canada they do not know what parts of the bands they can use legally in the US. VE3CI/W4 Heith Love talked with me about this situation the other day; it affects him. So you see, this unnecessary act is causing many problems that did not exist before and have no need to exist now—it should be rescinded.

Needless to say, I am no longer a member of the ARRL. An organization that willfully disrespects the majority of its membership is not a democratic organization.

Many of those 6000 Extra Class are old timers that grandfathered in and have not been on the air for many years; we have several locally.

Wayne, I wonder what has happened to the old steam in you—why has the fire gone out? Have you given up and joined the opposition? God help us!

George Taylor, W4PZS
1133 S.W. Fifth Place
Fort Lauderdale, Florida

In reference to your de W2NSD/1 editorial in the January issue, you should have a divorce vic-

tim's net. I don't think you would have any trouble in getting divorced people to talk. The QSO would start: "Let me tell you about my case—it's different." This type of QSO would last for hours and far into the morning.

Your mention of missionaries on the ham bands recalls to mind the fact that the Seventh-day Adventists (who were the cause of my troubles) did have and probably still do have, Bible networks. I used to get a kick out of listening to some unsuspecting ham joining the round table, and then getting the drift of what was going on—pulling out but fast.

A psychiatrist once said that most marriages were *dull*. I would challenge his statement and say that most successful marriages are *comfortable*. Marriages that are *exciting* quite often become *tiresome* and don't last too long.

So, perhaps QSO's are not so *dull* but *comfortable* and *most* hams like it that way.

George Partis, W6GHV
Founder & Executive Director
United States Divorce Reform, Inc.
Kenwood, California 95452

Each article published brings quite a mail bag from interested hams seeking further information or confirmation, not all of whom think to include an SASE (or even postage). The 4-BTV evaluation article netted me 22 such letters, mostly from people wanting to know if I really meant the antenna was that good (one old timer in Iowa asked bluntly, "What am I supposed to do with all that goddam wire,"—he got a polite reply and a sketch of a proposed layout of the radials for his small lot. 'The Gentrac' article has kept my mailbox busy—one from a missionary radio technician in the Amazon jungle who was attempting to build a Gentrac for his work and needed some advice.

Peter Lovelock, W6AJZ
Santa Monica, California

I would like to introduce a new and different net—The Handicappers Information Net. This net is now meeting Mondays, Wednesdays, and Fridays from 2000 to 2100 GMT on 7270 kHz. Although this is primarily a net for handicapped persons, all amateurs are invited to participate. Our goals are to aid handicapped persons in their daily personal problems, to help handicapped amateurs advance their class of license, and to interest and assist other handicapped people in obtaining an amateur license.

To make a success of our goals we need the help of many amateurs. Volunteers are needed to help set up stations for newly licensed handicapped amateurs and to give advice and encouragement to those studying for their licenses. Many members have donated various pieces of equipment while others have offered the loan of equipment for use by handicapped members.

At the present time we are helping three future members obtain their Novice licenses. In order to help more we need your help. For further information, check into the net or contact Otto Huggins, WA5TIK, Assistant Net Manager, L. E. "Gib" Gibbins, W5PCN, Equipment Co-ordinator, Sandy McDowell, W5QZY, or me.

This is a chance to give to others the pleasure of ham radio that you now enjoy and of having the personal satisfaction of knowing you have helped others.

Kathleen Wilson, WA5QOR
Net Manager
Handicappers Information Net

In your interesting article on Tesla you mentioned some references. Where? What did you do with them?

Owen Thompson, WA4NXA

I never thought you'd ask...here they are...ed.

Prodigal Genius: The Life of Nikola Tesla, John J. O'Neill, Ives Washburn, Inc. 1944.

Experiments with Alternate Currents of High Potential and High Frequency, Nikola Tesla, McGraw-Hill 1904.

Nikola Tesla: Lectures, Patents, Articles, Nikola Tesla Museum, Beograd, Yugoslavia 1956.

"Tesla's Oscillator and Other Inventions," Thomas Commerford Martin, *Century*, April, 1895.

"The Tesla Steam Turbine:" *Scientific American*, Sept. 30, 1911.

"Nikola Tesla," Kenneth M. Swezey, *Science*, 16 May, 1958.

"My Inventions," Nikola Tesla, *Electrical Experimenter*, a series begun February, 1919.

"Some Personal Recollections," Nikola Tesla, *Scientific American*, June 5, 1915.

"The Problem of Increasing Human Energy," Nikola Tesla, *Century*, May, 1900.

"Nikola Tesla–Last of the Pioneers?" Leland L. Anderson, *Journal of Engineering Education*, June, 1959.

It has been a number of years since I have written to you, nevertheless, I buy 73 and read de W2NSD/1 your editorials beat any other Ham Radio magazine on the market from QST to them all. I particularly have enjoyed your excursion around differents part of the globe, especially Europe. I would like to call your attention to January's issue on page 100, European VHF, by Lee Grimes, who is stationed there in Berlin. This article was one of the best I ever read; it was most informative. I am sure that there are thousands of us who enjoyed this article. The Editorial Liberties in the February issue brought some snickers about the ARRL requesting character references from some other Hams in order to renew your license or obtain a Ham license. Your article on Nikola Tesla and his contribution to electronics was well appreciated; however, I know I will never have the brains to pass the Extra Class exam. I am satisfied with the small amount of the frequency band that I'm allowed to operate on. I agree that the incentive deal didn't change the picture one iota as far as I can see.

Kenneth Mahoney, K6OPG

Reference is made to your letter of 7 February 1969 concerning amateur radio operations from Navassa Island.

Navassa Island is a small, rocky island with sheer sides extremely inhospitable in nature. It is uninhabited, lacks any source of potable water, and the terrain is rough and broken. The only installation on the island is an automated lighthouse maintained by the Coast Guard. A landing can only be accomplished from a small boat and requires scaling a 40-foot Jacobs ladder, which is an especially hazardous undertaking.

While we recognize that a well outfitted and organized group could reduce the hazards of visiting Navassa to some extent, we would not be able to supervise the operations proposed to the degree that would be necessary to assure the reasonable safety of the individuals concerned. Since the island is under the jurisdiction of the Coast Guard,

we would retain responsibility for the safety and well-being of visitors in the same way as we would for visitors to any other Coast Guard property.

With the exception of government employees on official business, since 1963 it has been the judgment of the Coast Guard that all requests from individuals to visit Navassa Island should be denied. There have been no new developments which would prompt us to change our position. The reasons for this position are several. In addition to the dangers present in effecting a landing together with the complete lack of facilities or means of sustenance, the location remote from civilization would make any visitor a likely Search and Rescue case. Furthermore, Haiti lays claim to Navassa as a Haitian dependency and refuses to recognize it as a U.S. territory. In view of this political situation a visit with radio equipment could easily be misinterpreted, as it was recently in the Middle East.

Moreover, call sign prefix "KC4" that was available for assignment to amateur stations has been deleted by the FCC, and the Commission no longer classes Navassa as a separate country for "DX" awards.

Therefore, the Coast Guard feels that, due to all of the surrounding circumstances, it is in the best interest of all concerned to deny individuals the authority to visit Navassa for any purpose save official business. Consequently, we must deny your request.

If the Coast Guard can provide any additional information or be of further assistance, please feel free to call.

P. E. Trimble
Vice Admiral, U.S. Coast Guard
Acting Commandant

(FCC is running DXCC for the ARRL now, I see....ed.)

Lines Created on the Passing of Robert Evans, W3NO

We say 73 to our dear friend, and strain to hear SK
For W3NO passes only to continue life,
Perhaps not far away.
We, here on this plane, shall hear that call again,
And know it bears another consciousness that we knew,
But still aware the old exists in us.
For what new wavelength, frequency or harmony do we seek,
In what direction do we steer within the universal spectrum,
To next discern that faint CQ DX?
Do our communicators search to find a device,
A demodulator to transform that invarient part of him,
That we might understand a message coming through?
We are beings of vibrations, constant motion, ever change.
Have 3FT and 3NO become as One, or only part of us?
The answer might be found within the realm of transformation of ourselves.
Amateurs have played their part in great discovery.
There awaits uncovery of a cosmic law by their probing mind.
A few, perhaps, will make the search and answers find.
Meanwhile, we really mean not to say farewell, but simply wait for us.
We're not far behind,
For how now he measures time.

S. Lee Maulsby, W3RKK

Million Dollar Suit Progress Report

As previously reported, the preliminary hearing before Judge Lieb in Federal Court in Tampa on Jan. 8th produced nothing concrete. The Judge asked for further briefs of law from both attorneys, to help him make a determination as to the proper disposition of the base. As a result, W4GJO's attorney has filed two further briefs, approximating 35 pages of well-researched law.

The opposing lawyers are asking that the case be remanded to Circuit Court in Sarasota County for trial on the "Nuisance," "electronic invasion of privacy" and million dollar damage charges. Our position is that Circuit Court has no jurisdiction in a matter involving a Federally granted privilege and responsibility. We also feel that it belongs in *no* court at this time, since the complainant fails to allege that he has exhausted his administrative remedies before the FCC. (Although, in fact, the FCC Field Engineers did investigate before the suit was ever filed, and gave W4GJO a clean bill.) We feel that the case should be dismissed by the Federal Judge, leaving the complainant free to take it to the FCC. Only if the FCC had found W4GJO at fault, and had he failed to comply with FCC orders, should the Federal Court be involved in enforcing an order of the FCC. This is clearly not the case. If the complainant feels the FCC ruling against him is in error, he should take it to Federal Appeals Court in Washington, D.C. We are currently awaiting the ruling from Judge Lieb.

In the meantime, our case against the complainant remains in the local court. The temporary injunction against the TVI complainant has been lifted, in return for sworn agreement that he will do nothing further to harass W5GJO or his family. There will probably be further hearings in this case before it comes to trial.

ARRL has provided much helpful material, but they feel that they cannot participate directly or financially until and unless the case comes to trial in a Federal Appeals court. Mr. Bob Booth, the ARRL General Counsel, continues to monitor the case closely, and is being provided with complete files of the great volume of paper-work involved in the case.

Good attorneys don't come cheap, and expenses to date exceed $2500. Few individual hams could handle this, but together it should be easy to finance fighting our case. Thanks to 73 Magazine, Florida DX Report, the QCWA News and many others, many contributions have been received, and needless to say, they are greatly appreciated. It's impossible to estimate what total costs may be. The case could be dismissed soon and no appeal made, or it could go on into other or higher courts and drag on indefinitely!

The Sarasota Amateur Radio Association, Inc., P. O. Box 3323, Sarasota, Florida 33578 has set up and is administering a fund to help underwrite legal costs in the case. Your help is urgently requested! Any unused funds will be returned to contributors furnishing names and addresses.

Not only is the future of ham radio as we know it today at stake, but it appears that this case strikes at the very power of the FCC to regulate! *Your* right to operate your amateur radio station without intimidation is involved!

Caveat Emptor?

★ Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

★ Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.

★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

★ We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

★ For $1 extra we can maintain a reply box for you.

★ We cannot check into each advertiser, so Caveat Emptor . . .

WANTED: Schematics & Instruction Manual for Farnsworth Model 600A camera & control monitor. Contact G. D. Petrizze, 2135 N. Allen Avenue, Altadena, California 91001.

T.V. CAMERAS—Heavy Duty Industrial. Trade-ins. These are beefed-up babies that really give "positively the brightest, clearest picture you ever saw!" Complete with Schematic lens and vidicon, $250. C.C.T.V. Center, Inc., Route 46, Little Falls, N.J. (201) 256-7379.

EXCELLENT NEW HW-32A with calibrator, manuals, plus Hygain 18V; all for $125. Jim Sandberg, K6HE, 1138 Rustic Road, Escondido, California.

THE OZAUKEE RADIO Club will have its annual hamfest at the Belgium Community Center at Belgium, Wisconsin, on May 25th, 1969. Further information can be obtained from Ozaukee R.C., Box 13, Port Washington, Wisconsin.

WANTED: Very low frequency receiver (MSL-5). Write WA7KDZ, Box 355, Kent, Washington 98031.

CONVERTERS, three transistor, low noise, 50-54 MHz in, 14-18 MHz out. Adjustable frequency, $5.00. Solid state decade amplifiers, $35. Syntelex, 39 Lucille, Dumont, N.J. 07628.

3000 V @ 3µf brand new GE Pyronal oil capacitors $3 each. Can mail, 3-lbs. each shipping wt., FOB. P. Wandelt, RR#1, Unadilla, New York 13849.

"NORTHERN CALIFORNIA HAMS." Best deals—new and reconditioned equipment. Write, call or stop for free estimate. The Wireless Shop, 1305 Tennessee, Vallejo, Calif. 707-643-2797.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oaklahd, California 94610.

WANTED: Military, commercial, surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

TEST EQUIPMENT WANTED: Any equipment made by Hewlett-Packard, Tektronix, General Radio, Stoddart, Measurements, Boonton. Also military types with URM-( ), USM-( ), TS-( ), SG-( ) and similar nomenclatures. Waveguide and coaxial components also needed. Please send accurate description of what you have to sell and its condition to Tucker Electronics Company, Box 1050, Garland, Texas 75040.

HAMFEST, May 25th at Wabash, Indiana, 4-H fairgrounds. $1.00 registration, no selling charge, rain or shine. Information? Write K9AYB, 434 Stitt Street, Wabash, Indiana 46992.

ATTENTION 160 METER FANS: Change any coax fed 75/80 meter inverted vee/dipole into an efficient 160 meter antenna. Adapts within seconds, right in the hamshack. PL-259 and SO-239 connectors. Perfect for residential areas. TOP BAND SYSTEMS' MODEL 86ADP 160 meter adaptor. $4.75 ppd. Martin Hartstein, 5349 Abbeyfield, Long Beach, California 90815.

Swan 350, VOX, calibrator 117 xc supply spare finals and antenna $350, **NCX-3** with **NCX-D** supply $200. Also two meter gear. WA2NM, 212-428-6133.

WANTED. Tents, Camping gear, Ampex or equal hi-fi stereo tape equipment. large 12½-16" Cassagerian telescope. Pentax & Cannon Demi 35 mm cameras. Will buy or swap for electronic equipment such as ham gear—CCTV & Broadcast equipment listed in our new flyer 969M1—free. Denson Electronic Corp., P.O.Box 85, Rockville, Conn. 06066, Telephone (203) 875-5198.

SWAP: DAVCO DR-30 wAC/DC PS-SPKR, Factory updated and overhauled, for SBE-33 wDC PS or SBE-34 or transceiver. Rankin, W4ZUS, NAVEOD-FAC, Indian Head, Md. 20640.

INDIANAPOLIS HAM Association ARRL Central Division—(Sat.) May 24, Lafayette Square (Airconditioned) Mall. Ham & Manufacturer displays—free flea market or $1.00 reserved. 1000-seat cinema technical sessions—$1.00 family registration (Ham-XYL-kids)—$2.00 at door. Banquet reservations $10 ea/$18 couple. Barry Goldwater (K7UGA/K3VIF) guest of honor with Stu Meyers as Master of Ceremonies. (Pre-reservations before May 12) Write: Indianapolis Ham Association, 309 Benton Drive, Indianapolis, Indiana, 46227.

EICO 753 Xcvr $140, homebrew, dc supply $30, Hustler mobile ant with 80M and 40M resonators with bumber mount $20, Hallicrafters S77 S.W. radio $40, WB6LGQ, 10926 Swinton Ave., Granada Hills, California 91344.

HAMFEST sponsored by Lancaster & Fairfield County ARC at Derby Downs one mile south of Lancaster, Ohio on BIS Road, Route 793, June 8th. Gigantic Swap Shop. $1.00 registration with prizes every half hour. Main prize drawing. Good food at reasonable prices.

WRL's used gear has trial-terms-guarantee! KWM1, $299.95; SR34AC, $149.95; HE45B, $79.95; Swan 240, $179.95; Galaxy V, $229.95; B&W 5100B, $109.95; HX20, $149.95; HX50, $249.95; Ameco R5, $59.95; SX146, $189.95; HR20, $79.95; NC303, $199.95; SB301, $269.95. Hundreds more. Free "blue book" list. WRL, Box 919, Council Bluffs, Iowa 51501.

The Augusta (Maine) Amateur Radio Club will hold their 10th annual Hamfest at the Calumet Club, route 104 Augusta on 15 June, preceeded with an open house and get together on Saturday evening the 14th at the same location. Pre-registration, adults $4.25; children under 12, $3.25; at the door, $5.00

COLLINS ARC-2 2-9 MHz transceiver $80. Quality. .55-42 MHz receiver Hallicrafters ARR-7, 6-position crystal filter, many features $80. Jerry Malone, WØMII, 27 Maple, Cambridge, Mass. 02139.

SOMERSET COUNTY Hamfest—June 8th, Casebeer Church Grove, Route 219, 7 miles north of Somerset, Pa. (9 a.m.-5 p.m.). Write Theodore J. Leonberger, K3RCI, Rd. 2, Rockwood, Pa. 15557.

St. PETERSBURG AMATEUR Radio Club, Inc. will hold its annual Hamfest at Lake Maggiore Park, entrance gate at 9th Street and 38th Avenue South, St. Petersburg, Florida, Sunday, May 18. All Hams and guests cordially invited. This is an old fashioned Hamfest with picnic lunch, swap table and prizes.

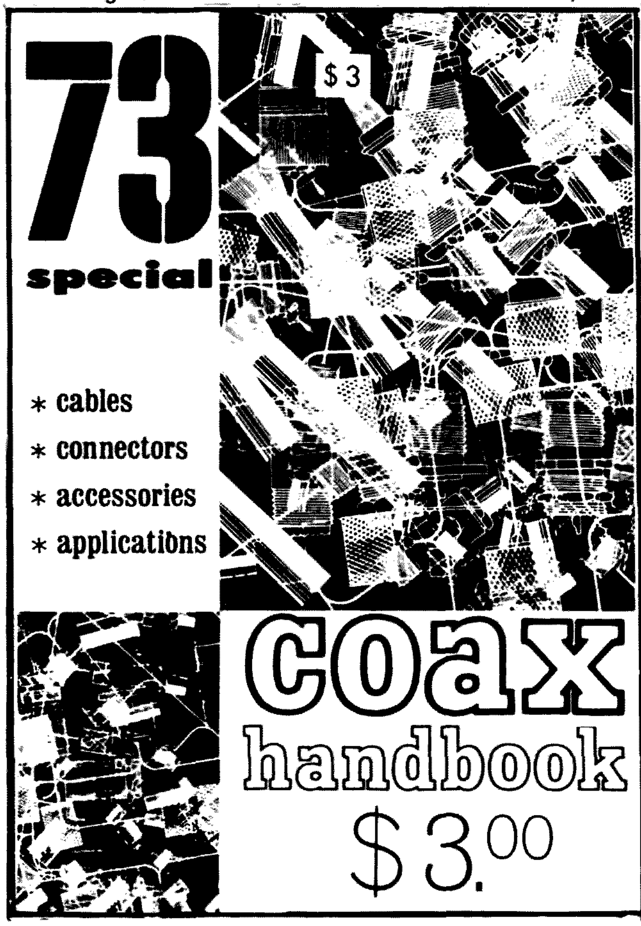
SPECIAL CLOSE-OUT SALE. Rectifiers, transistors, and many other electronic parts. Lowest prices. Send 15¢ for catalog. Electronic Components Co., P.O. Box 2902 S., Baton Rouge, La.

FANTASTIC—1969 New England ARRL Convention May 24-25, Swampcott, Massachusetts. Save money! Early bird registration $10.50 including Saturday dinner, dance and night club entertainment. Be a winner. Every major manufacturer will exhibit, plus top speakers from Science and Industry. Tickets: W1KCO, John McCormick, Berkeley Street, Taunton, Massachusetts.

INDIANAPOLIS HAM CONVENTION. (Sat.) May 24. (9 to 5) at beautiful Lafayette Square Mall. Indoor manufacturer's displays—for sale or auction. Free outdoor flea market. 80+ shops, cinema, for XYL & kids, inside airconditioned mall. Airports & Interstate—½ mile. Write: Indianapolis Ham Association, 309 Benton Drive, Indianapolis, Ind. 46227

3 Plastic Holders will frame and protect 60 cards, $1.00—or 10 holders, $3.00. Prepaid & guaranteed. Patent 3309805. Tepabco Box 198N, Gallatin, Tennessee 37066.

Need a Variable Capacitor for that homebrew project? We may have what you need at more than 50% below regular amateur net. Send for free flyer. A.R.C. Sales, 181 E. Wilson Bridge Road, Worthington, Ohio 43085.



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__ *$3.00 enclosed for one Coax Handbook, postpaid.*

The Atlanta Radio Club will hold its annual Hamfest on June 14 & 15 at the North DeKalb Shopping Center, Atlanta, Georgia. This promises to be one of the biggest and best Hamfests ever held in Atlanta. In addition to regular Hamfest activities, we are aiming for the largest amount of equipment to be bought, traded and sold, of any Hamfest in the Southeastern United States. There will be plenty of parking spaces for trucks and station wagons, along with inside space for displays. Further details may be obtained by writing John Fearon, 3384 Peachtree Rd., N.E., Suite 705, Atlanta, Ga. 30326.

The East Coast VHF Society will operate station WA2WEB/1 on 432 MHz from Mt. Equinox, Vermont on June 21 and 22, 1969. The express purpose of the expedition is to provide amateurs on the East Coast of the United States with the opportunity of contacting the state of Vermont on 432 MHz. The station will be on the air for approximately 24 hours for scheduled and non-scheduled contacts. Schedules are requested from interested amateurs. Write: East Coast VHF Society, P.O.Box 1263, Paterson, N.J. 07509. All correspondence and schedules will be confirmed prior to expedition.

Regulated Power Supply Kits, .6-4 AMP, $2.75 to $8.50. Zeners, thermistors, 25¢. 10A Triac, $1.75. Diodes, 5¢. Nixie, $5.00. Decimal Counter Kits, $3.50. Catalog. Murphy, 204 Roslyn Ave., Carle Place, N.Y. 11514.

AUCTION—June 8th, Manchester Radio Club at Tower Hill, Candia, N.H.—Map and information S.A.S.E. W1HPM, P.O.Box 661, Manchester, N.H. 03105.

How to Wrinkle a Wrinkle Finish

When I build, I seldom strive for compactness, since I like lots of room for modifications, pruning, and possible additional circuitry. I also like the neat appearance of rack mounting, and I'm fortunate in having a free source of 1/8" aluminum from which to fashion panels. Finally, I have predilection for black wrinkle finish. Don't ask me why—I just dig it.

In the past I've tried about every make of black wrinkle enamel in spray can I could find, and the results were never encouraging. Many of you have probably had similar experiences. It doesn't wrinkle. It doesn't dry for three days, and is soft enough to scratch with your fingernail for two or three weeks. At best, it looks like a sloppy job using standard spray enamel.

Finally, I hit on a solution. Follow the directions on the can: two *heavy* coats three minutes apart. Let it stand for about ten minutes after the second coat, and while it's standing, fire up the XYL's oven to 250 degrees. Pop in the panel and bake it for a good two hours. It thoroughly stinks up the house, but the result is beautiful even wrinkling that's as hard as any professional paint job.

Bob Grenell, W8RHR

PROPAGATION CHART

May, 1969 J. H. Nelson

SUN	MON	TUES	WED	THUR	FRI	SAT
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Legend: Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7	7	7	7	7A	7A	14	14	14
ARGENTINA	21	21	14A	14	7A	7A	14A	21	21	21A	21	21
AUSTRALIA	21	14A	14	14	7B	7	14	14	14	7B	14A	14
CANAL ZONE	21	21	14	14	14	14	14	14	21	21	21A	21A
ENGLAND	14	14	7A	7	7	14	14	14	14A	14A	14A	14
HAWAII	21	14	14	14	7A	7B	7	14	14	14	14	14
INDIA	14	14	7A	7B	7B	7A	14	14	14	14	14	14
JAPAN	14	14	14	7A	7B	7B	7A	14	14	14	14	14
MEXICO	21	14A	14	14	7A	7	14	14	14	14	21	21
PHILIPPINES	14	14	14	7B	7B	7B	7A	14	14	14	14	14
PUERTO RICO	14	14	14	7A	7	7A	14	14	14	14A	14A	14A
SOUTH AFRICA	14	7A	7B	14	14	14	21	21	21A	21	14	14
U. S. S. R.	7A	7	7	7	7B	14	14	14	14	14	14	14
WEST COAST	21	14A	14	14	7A	7	14	14	14	14	14	14

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	14	7A	7	7	7A	14	14	14	14
ARGENTINA	21	21	21	14	14	7A	14	21	21	21A	21	21
AUSTRALIA	21A	21	14	14	14	14	14	14	7A	7B	14A	21
CANAL ZONE	21	21	14A	14	14	14	14	21	21	21	21A	21A
ENGLAND	14	14	7A	7	7	7	14	14	14	14	14A	14
HAWAII	21	21	14	14	14	14	14	14	14	14	14A	14A
INDIA	14	14	14	7A	7B	7B	7B	7A	14	14	14	14
JAPAN	14	14	14	14	7B	7B	7	7A	14	14	14	14
MEXICO	14	14	14	7A	7	7	7A	14	14	14	14	14A
PHILIPPINES	14	14	14	14	7B	7B	7B	7A	14	14	14	14
PUERTO RICO	21	14A	14	14	7A	7A	14	14	14	21	21	21
SOUTH AFRICA	14	7A	7B	7B	7A	14	14	14	14	14A	14	14
U. S. S. R.	7A	7A	7	7	7B	7B	14	14	14	14	14	14

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7A	7A	7	7	7	7A	14	14	14
ARGENTINA	21	21	21	14	14	7A	14	14A	21	21	21A	21A
AUSTRALIA	28	28	21	21	14A	14	14	14	7A	7	14A	21
CANAL ZONE	21A	21	21	14	14	14	14	14	14A	21	21	21A
ENGLAND	14	14	7A	7	7	7	7B	14	14	14	14	14
HAWAII	21A	21A	21A	21	14	14	14	14	14	21	21	21
INDIA	14	14	14	14	7A	7B	7B	7A	14	14	14	14
JAPAN	14	14	14	14	14	14	7	7A	14	14	14	14
MEXICO	21	14A	14	14	7A	7	14	14	14	14	14A	21
PHILIPPINES	14	14	14	14	14	14	7B	7A	14	14	14	14
PUERTO RICO	21	21	14	14	14	7A	14	14	14	14	21	21
SOUTH AFRICA	14	7B	7B	7B	7B	7B	7B	14	14	14	14	14
U. S. S. R.	7A	7A	7	7	7B	7B	7B	7A	14	14	14	14
EAST COAST	21	14A	14	14	7A	7	14	14	14	14	14	14

A - Next higher frequency may be useful this period
B - Difficult circuit this period.

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June 1969
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73 Magazine #105, June 1969

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...de W2NSD/1

Wayne Green

Getting away from the seemingly uncontrolled confusion that gives birth each month to a new issue of 73 gave me a chance to give a little more thought to the role that amateur radio is playing in the world today. Lin and I had a few days to dash off for a short "vacation" before Kayla left us to get married, so we decided to go on one of those packaged European ski tours where they include a car in the deal. It was our first skiing in Europe.

One day of skiing in St. Anton, Austria and one in Zermatt, Switzerland forever cured me of wanting to ski in Europe. I waited for over five hours in Zermatt on the lift lines, some of which rivalled the mob scene I witnessed a few years ago when several thousand women became a screeching, unthinking mass trying to touch the Pope. It was worse than any subway crush in New York. Here we have lift lines, there they have lift mobs.

So, while Lin was busy memorizing the galleries, palaces and castles of Florence and Venice, I ate pasta and tried to put things into perspective.

Frankly, the more I think about the problems we have in amateur radio today, the more concerned I get. Amateur radio is far more important than I suspect anyone realizes. To most of us involved in it, amateur radio is a hobby for having fun. It most certainly is that. If it wasn't it wouldn't exist. Even the reasons given for the existence of amateur radio in the FCC regulations don't give the single, most important reason for amateur radio to exist.

Those FCC purposes for amateur radio have clouded the issue. They have focused attention on PICON, on emergency traffic handling, on technical developments, on incentive licensing, etc. While we can't dismiss these factors, they are very far from being the most important.

As I see it, and I'll be blunt, unless we get amateur radio moving ahead, get it expanding as it should, serious and permanent damage will be done to the United States. There is no question in my mind that amateur radio is the most important hobby in the world, by a wide margin.

When Russia sent up Sputnik and we found ourselves obviously second in the space race, our politicians made much hay over the missile gap and for a while there was a lot of worry about how to get our teenagers interested in getting into the sciences. We are, today, keeping up pretty well with our missiles and technology. But all of us recognize fully that electronics is a fast growing field and that as it expands we will have to have perhaps ten times as many engineers and technicians as we have today in just a few years.

You don't start being an engineer in middle age, you start in your teens. And, you don't start being an engineer in your teens if you are spending your time protesting, roving with a street gang, or dropping out. The reason we are able to have the number of engineers and technicians that we do today is very largely due to the influence of amateur radio on two or three hundred thousand teenagers in the last 50 years. Well over 80% of the high school hams go on to work in electronics and communications. What do you think would happen to our electronics industry if every man who got started via ham radio were to drop out?

Now, at a time when we should be doing everything in our power to see that amateur radio is exploding with new hams, we have ground to a halt. We should be working overtime to attract newcomers into our hobby. We should be setting up talks and demonstrations in high schools. We should be organizing code and theory classes in the schools. We should see that ham magazines and books are in the school libraries. We should put on public demonstrations of ham radio. Even notes on public bulletin boards suggesting that interested teenagers come over and see your station will help.

And, once we have them started we have to do everything we can to keep them from dropping out. Don't let them settle for just going part way. Don't let them drop out and

(continued on page 118)

New Ways of Generating Microwave Power

Charles S. Jones, K3PBY
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Clairton, Pennsylvania 15025

It is now more than a quarter of a century since a small group of physicists at the Bell Telephone Laboratory invented the transistor. The enormous technical progress that has been made in the art of semiconductor electronics during these years has been extraordinary. The field of solid state technology is moving so fast that one has difficulty in keeping up with current developments. This is especially true in the area of microwave technology. Here, semiconductors are making monumental strides that are causing a revolution in the design of microwave circuitry.

In this article I will discuss some of the most recent aspects of solid state application growth in the field of microwave power generation. Since the theory of operation of these devices is rather complex and involved, I have not devoted much attention to this area of thought. My main purpose is to shed light on what to expect from solid state microwave devices in the near future.

Today, one of the most versatile semiconductor materials is gallium arsenide. Its use has contributed greatly to the development of numerous solid state microwave devices. Transistors, varactors, microwave diodes and many other ultra-high devices are possible with gallium arsenide.

Just recently, another remarkable application for this multi-faceted semiconductor material was unearthed. It was discovered that a tiny chip of gallium arsenide can be made to emit microwaves simply by applying a steady dc voltage across it. This phenomenon, known as the Gunn Effect, is expected to revolutionize microwave technology. Ever since J. B. Gunn of the International Business Machine Corporation discovered this new solid state source of microwave radiation, engineers have been waiting for the potentially low-cost semiconductor to be made practical. All that would be required for a microwave source of power then would be a battery, a resonant cavity and the small chip of gallium arsenide. No longer would a microwave system require a klystron and its associated bulky power supply, or a radio-frequency oscillator with several stages of harmonic varactor multipliers, or a power limited microwave transistor.

Between the valence and conduction levels there is an energy level called the "forbidden" or depletion level, because no electron ever contains that exact energy level. The reason is not know, but the fact is that nature has prohibited certain energy levels.

Like silicon and germanium, gallium arsenide owes its semiconducting characteristics to the structure of its energy bands. These energy bands are shown in Fig. 1. Of course the depletion region in this illustration is amplified to a great extent. There is no sharp division between the crystal regions and the depletion region. As you move out from the junction between the P- and N-areas the charge density becomes less and less, and the number of charge carriers more and more.

At ordinary room temperature there will be very few electrons which will possess enough energy to cross the depletion region and therefore create a current flow. However, if the semiconductor material is doped with certain impurity atoms, electrons can be added at energy levels which are just below the conduction band. Very little energy is then required to boost these electrons across the depletion region and produce a flow of current.

These materials which are added to the semiconductor material are called donar impurities because each atom donates an

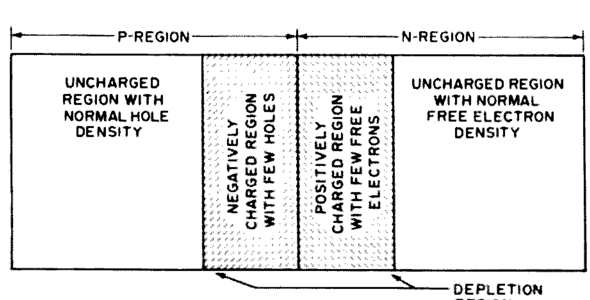

Fig. 1. The energy bands of a diode.

electron. This creates an N-type semiconductor material. Similarly, the semiconductor material can be made P-type by adding acceptor impurities. These will produce empty energy levels just above the top of the valence band. Here, the electrons can be driven out of the valence band into them, leaving holes behind.

To change the allegory a bit, let's see what's currently being accomplished with Gunn oscillators as microwave power generators. The field is moving so rapidly that it is difficult to pin down specific power and frequency figures at the present state of the art. A sample of some of the more recent lab results with Gunn oscillators are as follows: 1.5 watts peak power in the X band at Motorola Inc., Arizona; 140 milliwatts of CW at 6 gigahertz by Texas Instruments; and a full gallon of peak power at 1 gigahertz by the NASA Electronic Research Center, Cambridge, Mass.

With a good many experimental systems already successfully tested, the promise of achieving a low-cost microwave power generator is gradually nearing fulfillment. At the present time a British firm, Mullard Ltd., is marketing such a device for experimental purposes. Priced at 175 dollars, it is available in sample quantities. Granted, this is a pretty steep price tag. Keep in mind though that the first *rf* power transistors for the 80 meter band cost a pretty penny at first; now they can be purchased for less than a dollar.

Up to the present the high cost of vacuum-tube microwave sources (a small klystron and its power supply cost about a hundred dollars) and the complexity of system has seriously limited amateur radio experimentation in the microwave frequency range. The development of an extremely simple and economical microwave power generator, such as the Gunn oscillator, should do much to open the way to much more use of these frequencies by radio amateurs.

The Gunn oscillator is not the only new solid state device that looks promising as a generator of microwave power. Other semiconductor devices, such as avalanche-transit time diodes, are creating power-frequency combinations never before accomplished in solid state circuitry in the microwaves. Avalanche-transit time diodes are junction devices that depend for their operation on "avalanche breakdown", that is, the creation of extra charge carriers by collisions with atoms. As with the Gunn oscillator, they are able to amplify and oscillate due to their negative resistance characteristics.

As a class, avalanche-transit time diodes offer promise of reasonable power outputs at reasonable efficiencies in the range from a few gigahertz to many tens of gigahertz. Over much of this range they will be in direct competition with bulk gallium arsenide Gunn oscillators. Thus far, the tunnel diode has been out-distanced as a microwave power generator by both the avalanche-transit time diode and the Gunn oscillator. The avalanche-transit time diodes are expected to undergo a tenfold improvement within the next couple of years. Within five years, CW power output of one watt at 20 gigahertz may be commonplace.

At this time you are probably very curious as to how this phenomenon occurs. In this respect you aren't alone because a lot of engineers are wondering the same thing! The main features of the Gunn Effect now seem to be understood, but there is still a considerable amount of research work continuing in order to completely understand its behavior.

In a very basic sense, the operation of the Gunn oscillator can be explained as follows. When the dc voltage across a tiny crystal of gallium arsenide is slowly increased, there is a certain critical voltage where the semiconductor suddenly begins to produce a high-frequency oscillation. Capacitive probe measurements conducted by Gunn indicated that a dipole layer was moving through the semiconductor at a terrific velocity; about ten million centimeters per second. Gunn also observed that the time required for one complete pass through the semiconductor material corresponded to the period of the oscillations. For example, a chip of gallium arsenide that is 0.01 centimeters long oscillated at a frequency of one gigahertz.

An explanation of how gallium arsenide behaves is not as simple as for other more conventional semiconductor materials such as silicon and germanium. It requires our understanding quantum mechanics. These are the laws that govern atoms and electrons and the basic make-up of our physical world.

Within an atom of semiconductor material, all electrons exist in one of two energy states. Some are locked in an orbit and swing around the central structure of the atom at the speed of light. These electrons are said to be in the valence energy band. Others are free to move at random between the atoms of the crystal structure.

These electrons are able to carry current when an electric field is applied. These electrons are said to be in the conduction energy band. The word "energy" is repeated to emplasize that the electrons are constantly in motion, no matter what state they are in at the time.

Once the electrons are free in their bands, they can move under the influence of an electric field. The amount of current flow that will take place depends on the mobility of each type of charge carrier. The electrons are generally more mobile than holes.

The gallium arsenide conduction band has two valleys separated by a small energy gap. The electrons in the lower-energy valley have a greater degree of mobility than those in the upper-energy valley. When the voltage across a crystal of gallium arsenide is increased, there is a greater number of electrons excited into the upper (lower mobility) valley. As a result, the resistivity of the semiconducting material will increase as the voltage is increased.

When there are more electrons in the upper valley area than those in the lower valley area, the semiconductor assumes a negative resistance characteristic. Not all semiconductor materials have this distinctive feature.

To illustrate what is meant by negative resistance, consider the graphs given in **Fig. 2**. A normal conductor of electricity has a positive resistance in the sense that the current passing through it increases with increasing applied voltage (Fig. 2A). In gallium arsenide it is possible to have situation in which Ohm's law does not hold true; the current first increases with increasing applied voltage but then decreases with increasing voltage (**Fig. 2B**). The area where the current is decreasing as the voltage is increasing is called the negative resistance region of the semiconductor material.

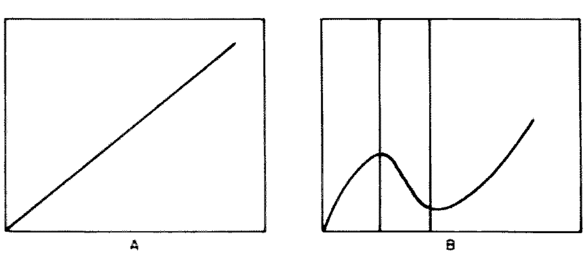

Fig. 2. The theory of positive and negative resistance are illustrated in these two graphs. A normal conductor of electricity has a positive resistance since the current passing through it increases with increasing applied voltage (Fig. 2A). In some semiconductor materials it is possible to have a situation in which the current first increases with increasing voltage but then decreases with increasing voltage (Fig. 2B). The area where the current is decreasing as the voltage is increasing is called the negative resistance region (shaded).

(courtesy Scientific American)

A chip of gallium arsenide is capable of oscillation and amplification at extremely high frequencies because of its negative resistance characteristics. Any circuit having feedback can be made to oscillate if its losses, which are positive reactances, are completely overcome. Negative resistance accomplishes this by exceeding the losses. This makes it possible for energy, once it starts moving in the circuit, to keep moving indefinitely. A circuit with enough negative resistance can overcome its losses. The opposite of loss is gain – or amplification!

Conclusion

There have been a great many promising proposals and suggested applications for these new semiconductor devices passed about in engineering circles. Some of them have advanced beyond the lab, others are still in the embryonic stages. With all the applications now being explored, it is clear that economical solid state devices for generating microwave power have passed the stage of being a lab stunt and entered the stage of becoming a beneficial addition to microwave technology. We can never know when some new insight or experimental breakthrough will bring additional advances in this field. I hope that it is not too optimistic to conclude that these new semiconductor devices will bring about a substantial increase in the use of the microwave frequency spectrum by radio amateurs in the not-too-distant future. In this article I have tried to tickle your imagination with some of the seeds of ideas that are destined to do just that.

. . . K3PBY

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Loaded Coat Hangers For Two Meters

Having recently acquired a Benton Harbor "lunch pail" of the two-meter variety, I decided to try my hand on that band. However, being a poor college student living in a tiny apartment, I was hard pressed for an antenna.

The antenna I needed had to be indoors and, therefore, small. Lack of money meant it had to be cheap. And, I had to reach the local two-meter gang.

A dipole and a whip proved unsuccessful. A ground plane seemed to be the answer. Five coat hangers and two coax connectors later, I had my antenna.

The coat hangers were cut into 20 inch straight lengths, with a loop bent in one end of each length. Four of the lengths were bolted through the loops to the top side of an SO-239 and bent down. The remaining wire was soldered into the center of a PL-259. (Rubber sealant may be used to guard against shorting.) A loop at the top aided in hanging the antenna from the ceiling of the apartment. The best dx so far has been about 50 miles.

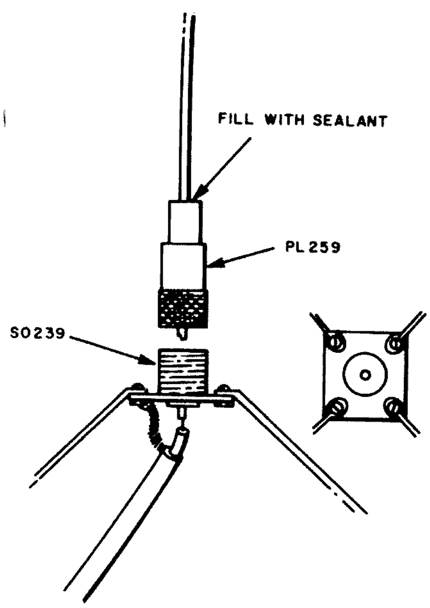

Fig. 1. Construction details for the loaded coat hanger for 2 meters.

I don't think this idea is new—but it works. *A word of caution:* Hang the antenna high enough so it won't be bumped into. You could lose an eye by running into it.

Dallas W. Williams, WAØMRG/Ø

Modification of VHF Transmitters for CW Operation

Martin J. Feeney, Jr., K1OYB
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Mt. View, Calif. 94040

Many DX contacts on the VHF bands are missed because of the lack of CW activity. This dearth of CW is usually due either to unwillingness on the part of the operator to give it a try, or because many rigs, commercial and homebrew, just don't have provision for CW operation, even in this age of enlightenment. To convince the former, I can only cite my 1250 mile QSO with W4MNT, Orlando, Florida. During this QSO I was running 70 watts, CW. I daresay this would have been difficult, if not impossible, using any other mode.

The transmitter I modified was the Tecraft TR-20, 220 MHz rig. However, the same approach can be used on many other rigs. The parts required are a DPDT toggle switch, closed circuit key jack, 7 pin miniature tube socket, .001 mF disc ceramic capacitor, OA2 VR tube, and a 15K, 10 watt adjustable resistor. Inspection of the chassis and the photographs will show the location of the components. The only critical point is to position the key jack as near as possible to the cathode pin (pin 2) of the final 6360.

The Phone-CW switch is wired so that in the Phone position the rig operates normally; in the CW position the modulation transformer secondary is shorted and the cathode circuit of the 6AQ5 modulators is opened. One part of the DPDT switch, closed in the CW position, is wired across the modulation transformer secondary. The other section is used to open the modulator circuit. This section should be open in the CW position. Unsolder the 180 ohm cathode resistor from pin 2 of the 6AQ5's. Run a wire from pin 2 of the 6AQ5's to the switch, and run another lead to the disconnected end of the cathode resistor. Tape all exposed joints.

Mount the VR tube socket and connect one end of the 15k resistor to pin 5; connect the other end of the resistor to the B+ pin on the power plug. Ground pin 2 of the VR tube socket. Replace the 6AU6 oscillator screen resistor, connected to pin 6, with a 1000 ohm, ½ watt unit. Connect one end of the resistor to pin 6 of the 6AU6 socket, and the other end to pin 5 of the VR tube socket. This will stabilize the oscillator stage, and prevent FM on Phone, and chirp on CW.

Next, mount the key jack. Wire it so that it is closed with the key out. Then unsolder pin 2 of the 6360 final stage. This is easier said than done, and may require temporary removal of other components in the area. If you are unfortunate enough to break off the pin in the process, as I was, remove the remains and replace it with a pin from

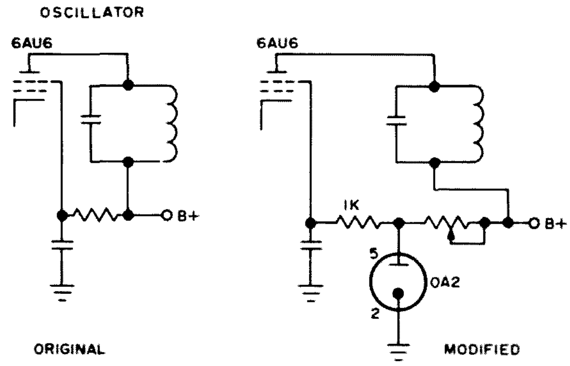

Fig. 1. Oscillator stage showing addition of VR tube.

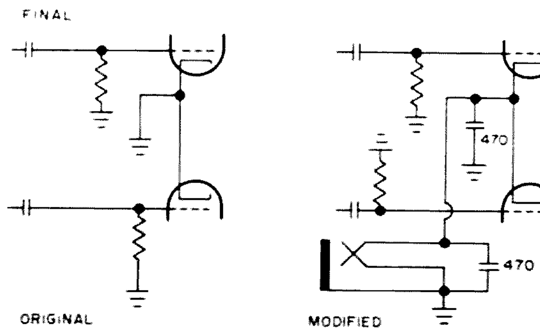

Fig. 2. Final stage indicating addition of key jack and by-pass capacitors.

another socket. Solder a 0.001 mfd disc capacitor from pin 2 to ground, and run a lead from pin 2 to the hot terminal of the key jack. Also, bypass the hot lead on the key jack to ground with a 0.001 mfd disc ceramic capacitor.

This completes the wiring. Replace all tubes; plug in an OA2, and set the adjustable resistor for about 10 ma through the OA2. With the switch in the phone position, the rig should tune up normally. In the CW position, the meter readings and the output should be somewhat higher. This is because the modulator load is removed from the power supply, causing the voltage to increase, and there is no longer a B+ drop across the modulation transformer secondary.

This scheme is applicable to nearly any small rig, and I have successfully employed cathode keying of a 5894 on 2 meters and an 829 on 6 meters. To put any other rig on CW, it is necessary only to open the final cathode circuit and install a key jack, and short the modulation transformer secondary. If the modulation transformer isn't shorted you probably will end up with a second-rate CW signal, and may be forced to purchase a new modulation transformer, modulator tubes, final, etc. Remember Lenz's Law! It isn't necessary to disable the modulator, but it does cut power consumption and is a bit more professional. This may be accomplished in many ways; opening the cathode, breaking the plate and screen circuits, opening the screen lead, etc. If your power supply has very good regulation, you may dispense with the VR tube, but it's cheap insurance against a poor signal.

This technique has been successfully applied to the Tecraft 220 transmitter and a 6360, 220 rig similar to the rig in the ARRL Handbook of a few years ago. Give it a try, get on VHF CW, and join the Great Society!

...K1OYB

Mondo Hamme

Bob Manning, K1YSD
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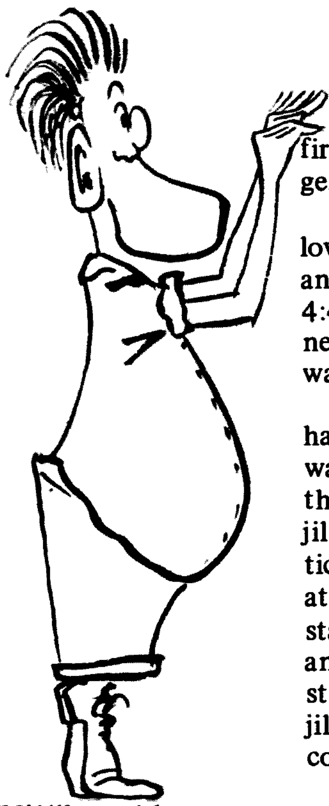

"OH NO! NOT AGAIN!!!" – with a nauseating SSSHHHHGGLLOPP!!! one sixth – or roughly one hefty handful – of a Sara Lee chocolate meringue cream pie whizzzed past my head and came to rest on my sound absorbent wall-covering, in the process, my T/R switch a new RCC certificate and an autographed 8 X 10 glossy of my hero, J. Croyden Seymour. [Poor ole J. Croyden! He was instrumental in interesting me in amateur radio and assisted in the planning of my ham shack. Regretably, he was prevented from seeing the completion process – having been struck down in one of the most bizarre accidents in homo sapien history.

It seems that a jilted young lover, who lived nearby, had decided to do away with himself by swallowing something toxic, then speeding to the home of his unrequited love, dramatically expiring on her door step. Unfortunately, he arbitrarily grabbed the first bottle in the medicine chest and ingested 2.9 litres of castor oil.

On the way to his destiny, the young lover was overcome by that 'irresistable urge" and, breaking all records for the Fat Man's 4:40, he sped into the men's room of the nearest gas station (appropriately enough, it was a "Flying 'A' " station).

At that precise moment in time, the hapless J. Croyden, an extremely frugal man, was attempting to climb under the door of the only vacant pay stall in the place. The jilted lover plunged headlong for that particular door, deposited his dime and attempted to gain entry. Since he was standing on J. Croyden's spine and the door and floor were making rapid and repeated staccato contacts with J. Croyden's head, the jilted lover couldn't get in and J. Croyden couldn't get up.

The jilted lover, loudly bemoaning his fate, was doing what appeared to be a combination "War" "Rain" and "Put out that damned fire" dance all over J. Croyden's prostrate form. J. Croyden, being alternately pounded on the jawbone by the floor and the cerebellum by the metalic door was gurgling, "I'll pay – I'll pay – dammit I'll pay!"

Within a very short span of time, some other highly predictable events took place – none of which are relevant to the story save that they left J. Croyden with some odd residual inhibitions.

Since that day, his spare time is spent wandering around town with a harried look on his face, putting coins into pay phones, parking meters and gum ball machines, keeping up a continual mumble of "Ya can't beat 'em! ya gotta pay! – ya just gotta pay!!"

At one time, unable to find a coin slot, J. Croyden just up and swallowed a fistful of coins – he lay in a hospital bed for three

days before there was any change.

J. Croyden's family tries to keep him home as much as possible – not only to save money – but because every time J. Croyden hears unexpected running footsteps behind him, the Fire Department must invariably be called to rescue him from the top of the nearest telephone pole, street sign or some precarious window ledge.]

All this flashed through my mind as I watched the artificially colored meringue oozing, like some science fiction glob, onto my SWR bridge, Vibroflex and G. E. Clock/Timer. I knew, with that instinctive inborn canniness of the long-married ham, that I – through my interest in amateur radio – had somehow irked my wife. Had I forgotten to take out the garbage? Overlooked an anniversary? Forgotten our 12-year-old kid's – whozzis's – name?

I didn't turn my head – uh uh – oh no! The last time I did that, I kept right on talking and brought my D-104 along with me. The second salvo consisted of a 2-week-old bagle which made forceful and direct contact with the D-104 – driving it and my partial plate half way to my esophagus. It took an hour and a half to get pieces of the D-104 out of my teeth and another hour to get pieces of my teeth out of the D-104.

"Sweetheart," I said, "I wish you'd correct for windage – that's the third clock you've hit since Newton Minnow's birthday. The clerk at the Radio Shop almost called the 'foam rubber taxi' the last time I asked for a 'meringue-proof' clock!"

"RAAWWKKKK!!!!!" screamed my wife – or some close approximation thereof – and another fragment of Sara Lee's epicurean delight found a spot dangerously close to the intake vent of the Air Conditioner.

"You never take me anywhere!" shrieked the distaff side.

"I do too!" I expertly reparte'd. "Why only last year I took you to the 'Anti lockjaw and Tongue Wagger's combination picnic, convention and orgy.' "

"Oh Shhure, you take me to those alphabet soup affairs. 'You're the ho hum' – 'how are the harmonicas?' and 'so you're YSD's XYZ?' "

"You got it all wrong, dear; I'm the O. M. – the kids are the harmonics and you're the XYL – L, not Z," I calmy replied.

"RAAAAWWWWWKKKK!!!! Ho hum – O. M. – harmonicas – harmon-

ics – XYL, XYZ, ABC, CBS, PDQ, who knows who cares! I feel like I'm at the Podunk Valley grammar school refereeing the semi-finals of a Sanskrit spelling bee – I I WANNA GO MEET PEOPLE WHO SPEAK WHOLE WORDS!!!!"

"Okay," sez I, "How about the night I took you to Howard Johnson's for dinner and cocktails?"

ZIPPLINGGG! – the empty pie plate caromed off my hand key, ricochetted into my message blank file and came to rest, face down, atop the head of our jittery, goggle-eyed poodle, who took off like a hairy hippie midget – a little more jittery and definitely more goggle eyed.

"Howard Johnson's! Howard Johnson's! *Howard Johnson's* – what a night that was. All the way there and all the way back you kept hollering into that junk you got stuck under the dashboard – 'I'm mobile – I'm mobile' – you got so much stuff under the dashboard that I have to ride in the back seat. . . . "

"But lover, you keep kicking holes in my speaker. . . . "

"I'll kick holes in your head, you cuckoo!!! and another thing – If you say, "I'm running mobile in the car tonight with a *hustler* one more time boy and. . . . "

"But dear," I said, "that's the name of the antenna."

"Antenna smantenna! Just one more time and you'll be talking to a divorce lawyer with a carved 'Z' on your forehead and that stupid antenna hangin' out of your navel!"

Drawing another breath, she said, "Do you remember what happened when we got to Howard Johnson's? I'll tell ya – you inhaled two martinis, tap tapp tapped your way through half the meal with your swizzle sticks then commandeered the paging system microphone and called CQ into a crowded

restaurant and made two contacts – one, a nearsighted insurance salesman who spent a goodly part of the evening trying to sell policies alternatively to a hat rack, the juke box and the post card rotisserie; and the other was an itinerant 'dirty book' salesman – (you sure he had mobile gear in his trunk?) Anyway, you spent the rest of the evening talking alphabet soup at the table.

"Why, we can't even have people over for an evening!"

"That's not so darlin'. We had the Carsons over just two weeks ago." I retorted, slyly trying to slip my son's whatziz name's football helmet over my head and earphones.

"That was another terrific evening," my wife blurted. "First, as they came through the door you started off with 'hi there, you've met my Wife, *W*hiskey, *I*ndia, *F*oxtrot, *E*cho, Wife and my oldest daughter, Linda, *L*ima, *I*ndia, *N*ovember, *D*elta, *A*lpha, Linda haven't you?' Then we later tried to watch TV, but you got off on UHF, VHF and TVI – more alphabet soup – then Harry started telling jokes and you brought out an old electronics magazine, opened to a dog-eared page and sat there roaring for a full fifteen minutes at the title alone – I still don't see what's so funny about an article entitled, "HOW TO MOUNT AN OSCILLOSCOPE!"

"And you kept calling Harry a stupid 'top' all night!"

"That's *lid,* dear," I said.

"Top, cover, cap, lid whatever . . . did you have to throw him out of the house just 'cause he asked if you could pick up police calls on your ham rig?"

"It wasn't just that, honey – but when he asked, 'how far will this thing pick up?' I told him 'exactly half way around the world in any direction' and he didn't even chuckle!" sed I.

"I could even take this stuff on a part-time basis, Bob, but last night you phoned and said you wouldn't be home until a hundred and sixteen Swahili – I never know what the hell you're talking about. . . . "

"That's 'sixteen hundred *Zulu,* sweetheart' "

"Swahili, Zulu or Watusi – what the hey – they're all members of the Bantu Nation. How come you can't just say 'four o'clock'??"

I was saved at this point by the ringing of the door bell.

"Come in!," I yelled overly loud and a little hysterically. The door opened and J. Croyden ambled into the shack and, with a 'clunk', deposited a nickel into the piggy bank we had installed just inside the door for just that purpose. "Ya gotta pay old son," said J. Croyden, and began to survey the shack as my wife headed for the kitchen.

Noticing the Sara Lee ingredients dripping on, over and around various pieces of equipment, he said, "Well, either someone sent you a chocolate parfait time bomb or you been having troubles with the XYL again."

"No initials puuuleeease!! I'm in enough trouble already, J. Croyden!"

"Sorry, son." 'clunk', another nickel . . . "what started if off?"

"Well," I said, wiping chocolate goo out of a phone jack – "I guess I forgot an anniversary – or I haven't been paying enough attention to the wife – or some foolish thing like that – last year it was because she wanted a 'second' dress!"

"Tough" said J. Croyden – searching for another coin – finding none, he wrote out an I. O. U. and stuck *it* into the piggy bank.

"I suppose it all started when my Mother-in-law was here. She looked up at my tower and tri-bander and asked what it was – so I told her it was a clothesline for the Jolly Green Giant – Ya know what I wish, J. Croyden? What I really really wish??

"Whazzat??"

"I wish to hell I had a way of ending this article – thats what I wish!"

"There is no end, old son," said J. Croyden "It's a vignette!"

"MONDO HAMME – IT'S A HAMS LIFE. . . . "

...K1YSD

Convention Hotel Burns

On May 9th, exactly two weeks before the New England ARRL Convention in Swampscott, just as all of the final details had finally been ironed out by the convention committee, the New Ocean House Hotel managed, with the help of a weak water supply from the town, to burn to the ground. Some very fast footwork on the part of the committee resulted in their obtaining the Statler-Hilton as an alternate. The convention will come off on the same days as planned, but in downtown Boston instead of out at Swampscott.

Straightforward SSB for 6 Meters

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Canada

There have been many different circuits put forward over the years for getting an SSB signal on 6 meters. They range from the simple transverter to the full-fledged single band affair. This little unit was intended mainly for field day or portable use; however, it now forms the backbone for my station, being used directly on 6 meters and with transverters on 144 and 432 MHz. It was designed to be simple yet effective; thus the PTT and single conversion with option of spot frequency injection or VXO. The 2E26 final provides about 30 watts PEP input; however, substitution of a 6146 with suitable changes in power supply voltages would almost triple the power input.

L1–30T 28 e. on 3/8" form. Link 2T of hookup wire at center.
L2–12T 18 tinned airwound, 3/4" O.D., 1 1/8" long. Link 2T hookup wire at center.
L3–15T 28 e. on 5/16" form. Link 1T hookup wire at "cold" end.
L4–6T 18 tinned airwound, 3/4" O.D., 7/8" long. Link 1T hookup wire at "cold" end.
L5–9T 18 tinned airwound, 3/4" O.D., 1¼" long. Link 1T of hookup wire at "cold" end.
L6–4T 18 tinned airwound, 1" O.D., 1" long.
PC–3T 18 tinned on 47 ohm lw resistor.
T1, T2–modified 10.7 mhz *if* transformers. See text of article.
C1, C2–part of neutralizing circuit. See text.

Table 1—Data on coils and special components.

The Circuit

The block diagram of **Fig. 1** illustrates the overall layout of the exciter. The 7360 oscillator balanced modulator is a conventional circuit in which the cathode, grid and screen form the oscillator circuit while the plates and deflection electrodes are utilized in the balanced modulator circuitry. The DSB signal produced in the 7360 tank circuit is passed through the 9 MHz filter at which point one of the sidebands is removed. After amplification in the 6AU6 *if* amplifier, the 9 MHz SSB energy is applied to the 7360 balanced mixer. 41 MHz energy fed to the grid of the 7360 mixer is cancelled out in its tank circuit. The 5 pF butterfly capacitor is brought to the front panel as the "mixer tune" control. CW operation is provided through cathode keying of the mixer stage and has proved to be quite satisfactory.

The 12BY7 functions as a straight-through class A amplifier whose plate circuit trimmer appears on the front panel as the "driver tune" control. Link coupling to the grid of the 2E26 is used to further attenuate any undesired feedthrough. Neutralization of the 12BY7 was not found necessary because of careful shielding across the tube socket below the chassis. With suitable pin connection changes, a 6CL6 would serve as a good substitute for the 12BY7. The 2E26 final operates in class AB_1 in a conventional circuit employing capacitive neutralization.

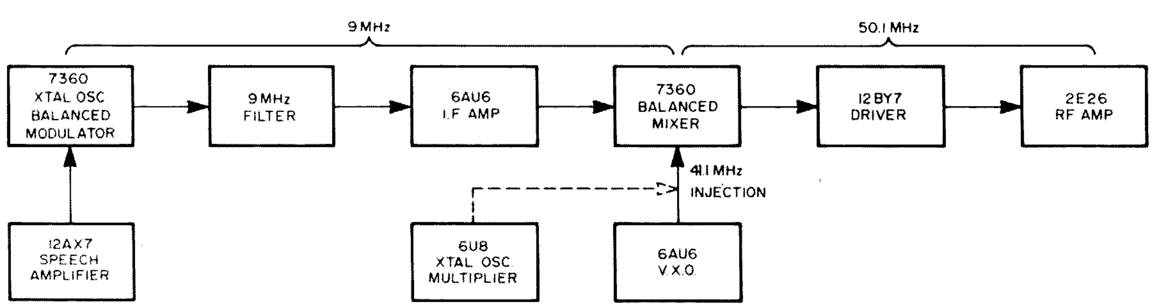


Fig. 1. Block diagram of the *rf* section. Single conversion path is illustrated.

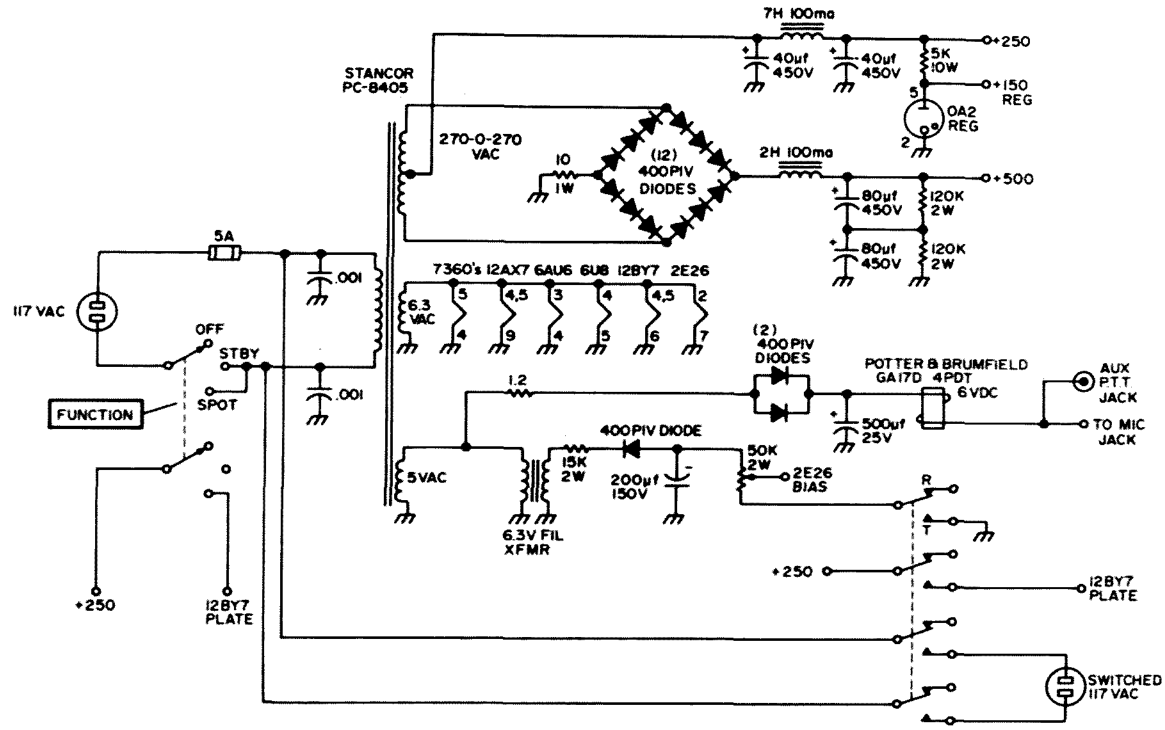


Fig. 2. Power supply and control circuitry. The controls, which are brought to the front panel, are shown in boxes.

Power Supply And Control Circuits

The power supply (**Fig.** 2) may consist of any common "TV" type transformer functioning in a dual voltage arrangement; the final's plate voltage being provided by bridge rectification, and the lower plate voltage by full-wave rectification through two legs of the bridge. Bias voltage for the final amplifier is derived from a reverse-connected 6 volt filament transformer connected to the used 5 volt filament winding of the power transformer. Transmit operation is provided by grounding of the floating side of the 6 volt dc relay. This may be accomplished with a push-to-talk microphone or by an auxiliary "transmit" switch. When not transmitting, plate voltage is removed from the 12BY7 to allow it to run cooler. The 2E26 bias is increased during standby by ungrounding one end of the bias adjust potentiometer.

Construction

Considerable thought went into the layout of this transmitter. Since the components are standard, builders may duplicate the layout if they wish. As detailed in **Fig.** 3, the 7360 sideband generator and the 12AX7 speech amplifier are located next to the front panel. Consequently the three controls and the jack associated with these stages can be mounted directly on the front panel without excessive lead length. The main chassis was assembled from aluminum, while the shielding was cut from thin brass sheet. As illustrated in the photographs, brass or copper partitions are placed across the *if* amplifier, mixer and driver tube sockets. All ground connections can be made directly to these partitions eliminating the need for ground lugs. Two of the partitions also serve as mounting for the mixer and driver tune controls. The 2E26 final is completely enclosed in a compartment at the rear of the chassis. A suitable enclosure can

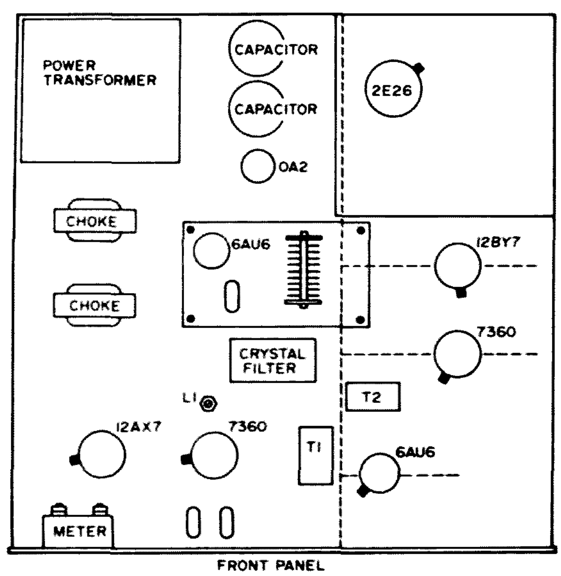


Fig. 3. Component layout viewed from above. Dashed lines indicate partition placement below chassis. The tab at each socket indicates position of pin 1.

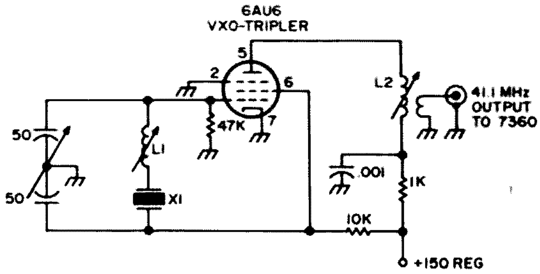


Fig. 4. Schematic diagram of the vxo tripler.

L1–30T #34 closewound on ¼" ceramic form.
L2–15T #28 closewound on ¼" form. 2T link of hookup wire.
X1–HC6/U xtal (fundamental). A 13.715 mhz crystal covers approx. 50.100 to 50.145 mhz.

often be salvaged from the high voltage "cage" of older style TV receivers. Extensions to the front panel for the mixer, driver and final amplifier controls were made from ¼ inch brass tubing. Short lengths of tight-fitting rubber tubing were used to couple the extensions to the capacitor shafts.

There are two small subassemblies used in the construction. The bridge rectifier diodes are assembled on a phenolic board which is bolted vertically underneath the chassis. Small holes are drilled in the board; the leads of adjacent diodes are placed through a hole, bent over, clipped, and then soldered together. If desired, 270 K resistors and .002 disk ceramics may be paralleled with the diodes to give voltage equalization and transient protection. The components associated with the rf output meter are mounted on a terminal strip which is bolted inside the 2E26 compartment near the antenna jack. A shielded lead carries the rectified voltage to the meter on the panel.

The 41.1 MHz injection is supplied by a VXO assembly built on a small plate and mounted above the main chassis. Certain of the VXO components such as the crystal socket and tuning capacitor are mounted ¼ to ½ inch from the plate to minimize capacitance to ground.

The usual VHF wiring techniques must be observed in order to produce stable TVI-free operation. All filament leads should be shielded and .001 disk ceramics should be placed from the hot filament lead to ground at each tube socket. In the higher frequency rf stages, lead length should be kept short. Grounding should be done as directly as possible and it is desirable to have only one or two common ground points for each stage. All plate voltage leads to the mixer, driver, and final, are routed through the main partition with feed-through capacitors.

Special Components

The 10.7 MHz *if* transformers used in the 6AU6 amplifier, are an older style of transformer using slug-tuned windings. They are more easily adapted than the smaller "K-Tran" type. In T_1 the primary winding was removed and replaced with a 3 turn link. The secondary of T_1 is moved down to 9 MHz by the addition of a mica capacitor. In

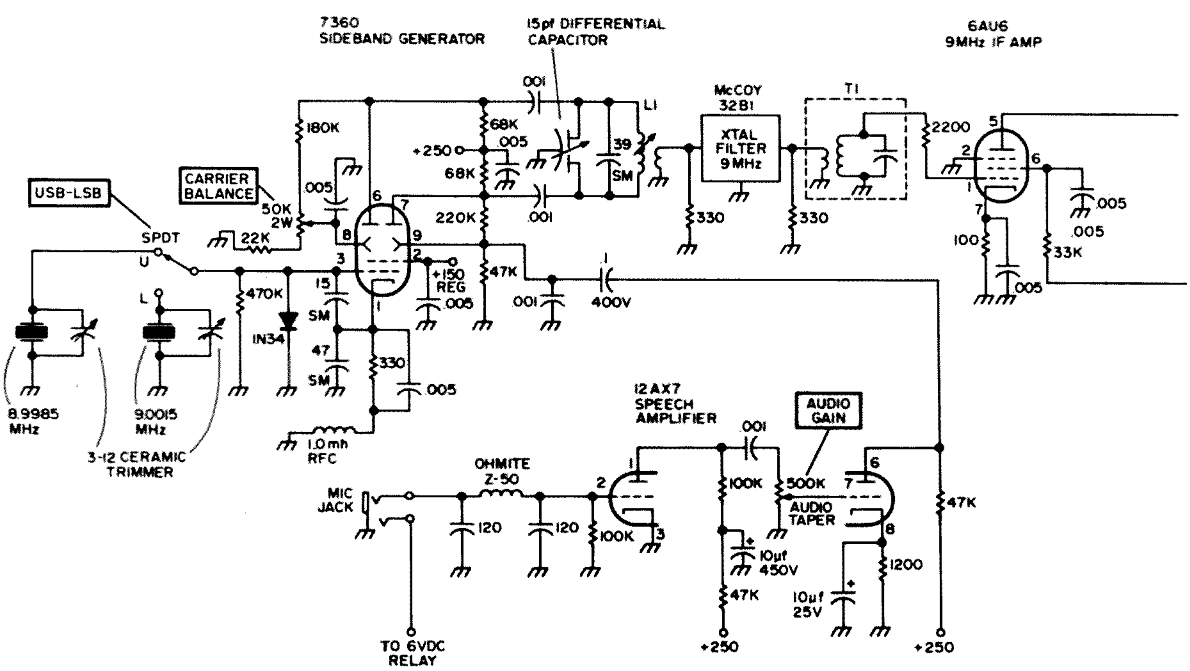


Fig. 6. Circuitry of 50 mhz exciter. Controls brought to the front panel are shown in boxes.

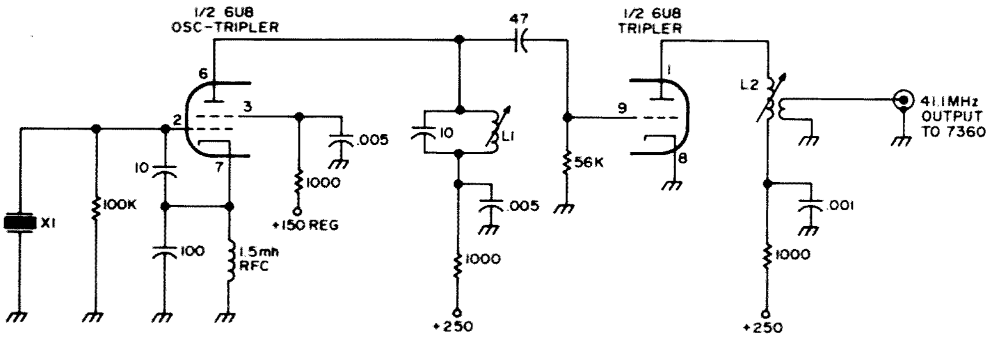


Fig. 5. Diagram for the oscillator tripler.

L1–26T #28 Closewound on ¼" form.
L2–15T #28 Closewound on ¼" form. Link 2T of hookup wire.
X1–FT243 surplus xtal. A 6.850 mhz crystal will give a spot frequency of 50.100 mhz.

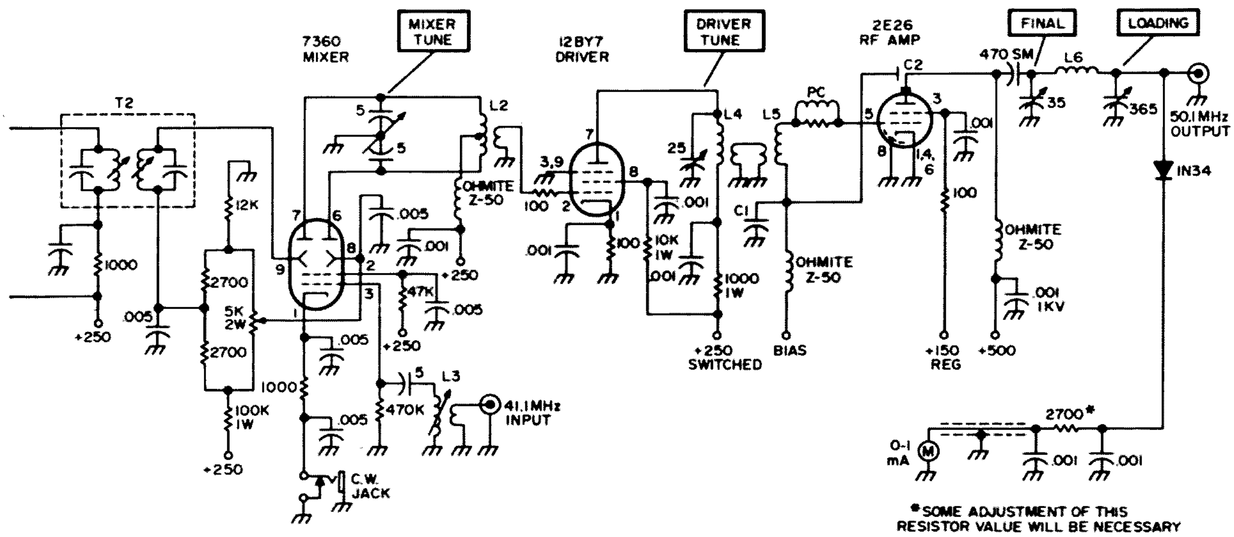
a similar fashion the primary and secondary of T_2 are lowered in frequency.

Some will argue that L_1 should be bifilar wound. Both a conventional and bifilar winding were tried and no significant difference in carrier suppression was noted. The differential capacitor associated with L_1 was constructed by taking a regular air trimmer, setting its rotor at half mesh and after inserting cardboard wedges between the stator plates, cutting through the stator with a fine toothed hacksaw blade. Of course this capacitor is available as a regular item if you can get your hands on one.

The 2E26 final is stabilized with capacitive neutralization. Capacitor C_1 should be mica and will be in the 330 to 560 pF range while C_2 is simply a stiff wire passed up through the chassis into the final amplifier compartment and placed near the tube plate.

Tuneup and Adjustment

It is assumed that the constructor will have checked all coils for approximate resonance (with the tubes in their sockets incidentally). Applying line voltage and setting the function switch in the standby position will place plate voltage on all stages up to the 12BY7 driver. A VTVM with an rf probe is almost mandatory for tuneup. Place the rf probe at the 6AU6 grid pin and adjust the carrier balance control to secure a reading. With the differential capacitor set at center adjust L_1 and T_1 for a peak reading. The differential capacitor is then adjust-



ed for a null. Set the ceramic trimmers across the carrier oscillator crystals at minimum setting and while switching from USB and LSB positions check to see that the VTVM reading remains about the same. This indicates that the crystals are centered reasonably well on the filter curve. Proceeding next to the 7360 mixer, place the probe on pin 9 and adjust both windings of T_2 for a maximum reading. Then with 41.1 MHz energy applied check pin 3 for a reading. It should be about 1 volt with L_3 adjusted to resonance. The next step is to remove the 6AU6 *if* tube to prevent 9 MHz energy from reaching the 7360. With the probe at the center-tap of L_2 adjust the 5K 2w potentiometer for minimum 41.1 MHz feedthrough.

Apply voltage to the 12BY7 with a temporary jumper and with the probe at pin 5 of the 2E26, peak L_2 and L_4 and adjust L_5 by the "squeeze" method. Moving the probe to the plate of the 2E26 adjust C_1 and/or C_2 for minimum feedthrough of 50 MHz signal.

A fairly satisfactory alignment of the carrier oscillator crystals can be accomplished as follows: with the rf probe at pin 9 of the 7360 mixer and with some carrier inserted increase capacity across the 9.0015 MHz crystal in order to move it down into the filter passband. Note the VTVM reading and then adjust the trimmer to yield a reading approximately three-quarters of the "passband" reading. Set the 8.9985 MHz trimmer to give a similar reading.

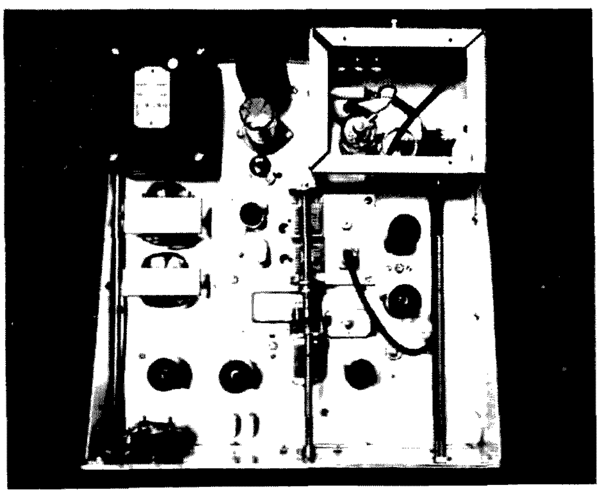
Afterthoughts

Some builders will wish to modify some of the circuitry to fit their likings and their junk boxes. One improvement would be a four position function switch to allow for a "manual" operate position. In the control section, by use of the negative bias voltage to disable the low-level rf stages one could use a relay with fewer contacts. Furthermore, only one side of the ac line need be opened for the switched 117 VAC.

The idea of tripling in the VXO tube was suggested by W2ALL and has proved very satisfactory. VXO shift was held to approximately 40 kHz to give maximum stability, but with more series inductance coverage of 100 kHz should be possible with good stability.

Building the exciter consumed quite a few hours of my spare time, but I enjoyed it, and am looking forward to building a transistorized version in the future.

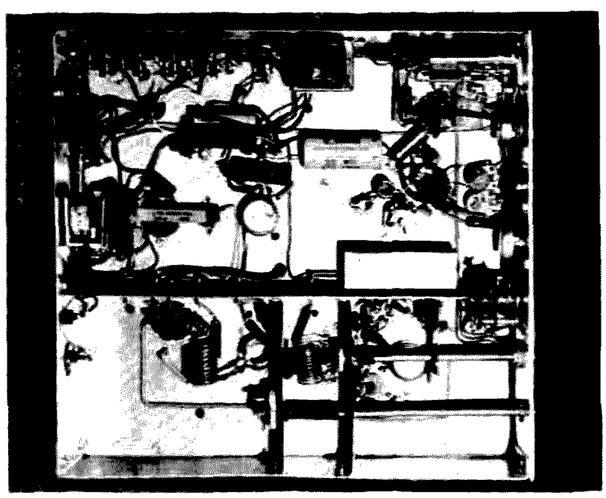
...VE4RE

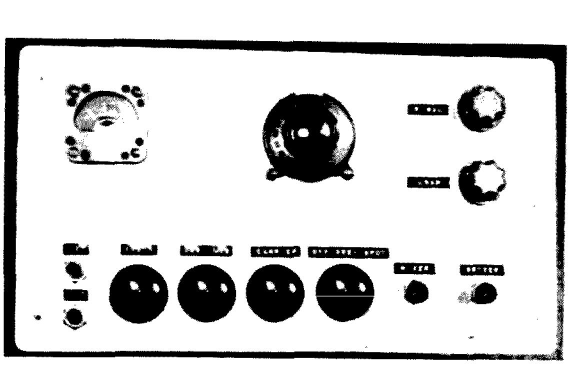


Top view of the 6 meter SSB exciter.

Bottom view of the construction of the 6-meter rig.

Front panel showing all controls.





The 432'er, Solid State

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Peterborough, New Hampshire 03458

This is a low-cost, all-solid state, A.M. rig complete with superhet receiver, to explore the possibilities of the entire 420 to 450 mhz band, to use in a car, boat, camping, on mountain tops, even the *walk-up* ones, and to have fun with.

You cannot use it to talk to the lads with narrow-band *if* sets clustered around 432 mhz, until you add the crystal controlled oscillator-exciter later. The *rf* amplifier is right there ready to have the crystal job plugged into it, but for the moment it is a lot easier and quicker to plug in a simple oscillator. This is the famous MOPA (Master-oscillator-power-amplifier). It takes a receiver with a bandwidth of several tens of khz, like the Gonset Communicator Three, to receive an MOPA signal on the 420 to 450 megacycle band, but just wait and see what you do with rigs like these!

As soon as you do add the crystal part you can talk to those sharp boys on 432. Then if you plug in a narrow-band *if* (like 455 khz) and a crystal-controlled local oscillator as well, you will have the best. But, and it's a mighty big "BUT," you will then have to use some kind of a tunable *if* front end.

The 432'er solid state receiver

RF Stage. Like sticking your hand into a basket of snakes! Now, I've built plenty of six and two meter *rf* stages, with various transistors, and they worked fine. But, up around 432, things are different! I've made up tube *rf* stages, as in 73 Magazine, 1963-1964, oscillators galore, and assumed that the small signal *rf* stage would be duck soup. Nothing doing! As soon as I started to bring up the gain, using a tuned base input circuit, and tuned collector output, *oscillation*! The more I matched things, the more it oscillated. The trouble with transistors today is they're just too darn hot! Also, holding to the policy here of never writing up anything not actually on the air at the shack, one and a half full days went by on this item alone. The GE "Microtabs" worked. So did the 918s, the 2n3600 RCA units were good, the KMC 2n2502s gave fine gain but oscillated more, and the Fairchild MT1116 gave the greatest gain. For $40, they ought to.

Neutralization was tried. No good so far. Oh, I haven't given up on that by any means. It's just another challenge (the story of my life) to be taken up later.

I suspect the internal resistive feedback as well as the capacitive feedback to be causing the trouble. More later, I hope.

So, to get on with the actual circuit that does work well without oscillation, Fig. 1 shows the schematic. The input cable is matched, not perfectly but good enough, by CI, which gets to be pretty large because those base-emitter diodes have an amazingly low impedance as you go up in the hundreds of megahertz. I tried various kinds of strap and capacitors for pi networks into the base. Too susceptible to oscillation. Matched to the cable, but untuned, does the job. That little one K resistor from the base helps a lot also; partly dc-wise, into the bias network.

Table 1 shows some comparison gains with different transistors. An *rf* stage of this kind has two main purposes. A) To set the noise figure. B) To provide some gain and a

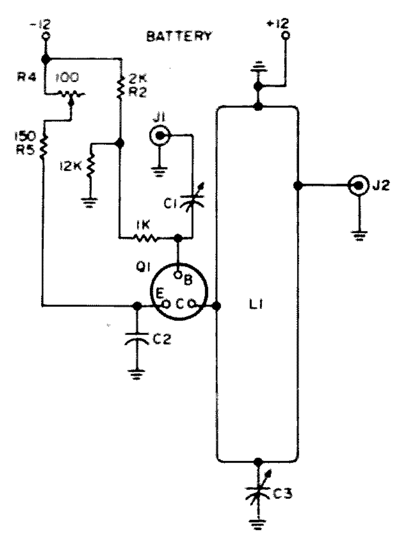


Fig. 1. *RF* stage 432 m.c.

Parts List

CI = Ceramic Trimmer, 5-30 pf.
C2 = Brass plate by-pass.
C3 = Johnson 9 plate, Type "M."

TRANSISTOR	GAIN (TIMES)
MT 1116	350
KMC 2502	340
KMC 2502	420
918	240
918	25
MICROTAB	21
2N3600	240

Table 1. RF stage gains with different transistors.

lot of freedom from image, spurious, and harmonic mixing. Not too many unwanted signals get past that half-inch copper strap!

Bear in mind that we are setting up here a "Gonset Communicator" type of rig, with a complete receiver and transmitter, and that you can expect to put in a real low-noise stage in front later to "set" the noise figure at some better and impossible-sounding figure like 1.7 db, or thereabouts. This will help you pull in that elusive guy you hear way down in the noise some evenings.

Also, more power can be added to the transmitter later. That takes a real stuffed pocketbook though. I hope to be able to help with this item later.

When you get past the base circuit, watch the variable emitter resistor. If you're really looking for good adjustment make it variable. I wound up with 100 ohms fixed which gives a little under 10 ma of current. In any case, you should provide a variable resistor for tune-up first, because almost every solid state device (trade name for transistor) varies from one to another, even with units of the same number and manufacturer.

For emitter by-pass, I used the old reliable brass plate, nylon bolt, and thin fiberglass insulation, about three mils thick. Keep the emitter lead as short as possible. The final length in this model was between one eighth and three sixteenths of an inch.

The collector circuit is of the strap-line type and not too critical, tapping the collector down on the strap is very beneficial as to gain freedom from oscillation, raising the Q, etc.

The circuit as shown in Fig. 1 shows mainly a large strap, and this is as it should be because the collector circuit is where the amplified power is to be found, and in this receiver with just one *rf* stage, at least to start with, we used a strap to get all the Q and filtering possible.

Fig. 2 shows the *rf* input side view with the input jack on the rear panel of the minibox. Once again, I use "phono-jacks" because they work. Use the ones with the ceramic insulation. Or "BNC" types if you like. A copper clad base board is bolted to the bottom of the

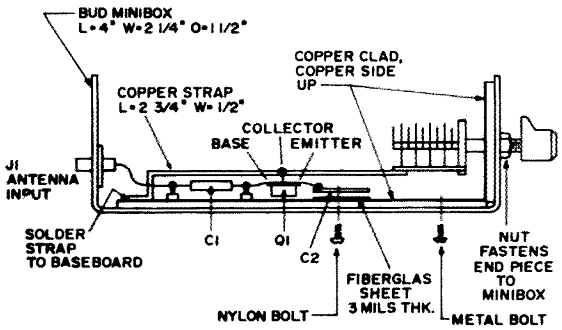


Fig. 2. Side view, *rf* stage.

minibox simply for convenience in soldering grounds, etc.

Fig. 3 is a top view which I hope is nearly self-explanatory. Fig. 4 likewise. C3 can be used to fasten the copper clad end piece to one end of the minibox.

Dimensions are shown in Fig. 3, adjusted to fit into a minibox, making a complete self-contained unit with input and output jacks. As mentioned in the main preamble on the 432'er, a "Rack and Panel" type of carrier is used, but small in size, made of wood, with aluminum paint sprayed on. It is very flex-

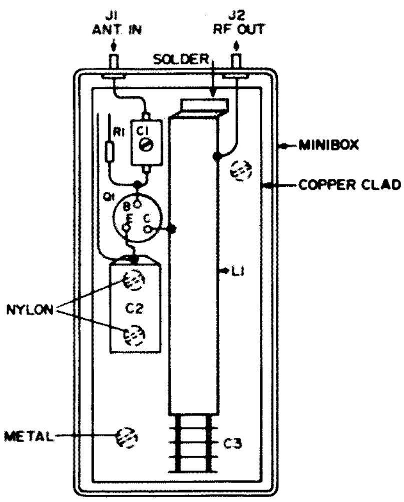


Fig. 3. Top view *rf* stage, 432 m.c.

ible to use, as you can fix the units on shelves, or use the sides like a rack.

It has a handle of dowel wood on top, antenna on the side, lantern batteries with six watts dc capability on the lowest shelf along with the *af* and loudspeaker, *af* amplifier-modulator next, then the transmitter, *if* near

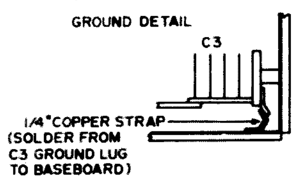


Fig. 4. Ground detail.

the top, and *rf* head on the top shelf. Everything comes out at a moment's notice for adjustment, change or repair, and the whole deal has considerable "growth possibilities built-in" as they say on Madison Avenue. So you can add an extreme low-noise *rf* stage, change to or add a narrow-band *if* strip, etc, etc. Don't say I didn't warn you!

Power supply for the *rf* stage is twelve volts at ten milliamps or less, depending on where you set the emitter resistor. It also works well on one of those nine volt transistor batteries. I intend to standardize on the lantern-type batteries from now on. Union Carbide rates theirs at half an ampere maxi-

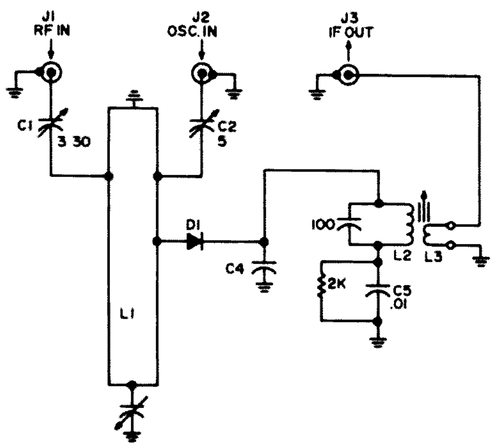


Fig. 5. Schematic, mixer, 432 m.c.

Parts List

CI = 3-30 trimmer.
C2 = Ceramic Trimmer (about 5 pf maximum) (ARCO 400).
C3 = Johnson Type M, 9 plate.
C4 = Brass plate capacitor.
D1 = Good uhf diode.

mum, which is six watts of dc power, with two of them at twelve volts, which is about all you can easily carry up some of those good DX mountains by hand.

There are some intriguing new small non-spillable storage batteries out also, which will go for more watts, later on. Twleve watts dc seems to have good possibilities to me though.

Using a combination regenerative single transistor in an oscillator-dipper-detector circuit, I have pulled in and identified all five Massachusetts UHF TV stations between 500 and 600 mhz from here in Peterborough, N.H., using just the tuned circuit on the bench as an antenna. For security, tune up and check the mixer circuit with just a dc meter (see **Fig. 10**), and even then watch out. In Melrose, Mass., the Malden TV station is about 3 to 4 miles away and would move a meter from a single diode on the bench! Don't forget, those lads put out hundreds of *kilowatts* ERP.

Connecting everything up, the meter went off scale as soon as I hit 432 mhz with C1. Things got even better as the minibox cover was put on and the output went up a little. A high Q fully enclosed signal circuit is nice, because don't forget, you're going to follow it with a high gain *if* amplifier which will pull in signals of less than a microvolt. And these signals should be your new contact from across the state, not from the TV station in town. Those Bud Miniboxes are not perfect of course. Some more self-tapping screws around the edges will help to seal unwanted *rf* out and cut down on noise that can be caused by slight motion of an improperly sealed cover.

With the dimensions given, 432 comes close to the middle of the dial. Don't forget, we want to tune our whole band of 420 to 450. After all it's still ours! Yet!

The six megacycle *if* output coil is next, and a painless method of getting this inductance right, which also serves to make up the *if* coils, is detailed next. (Skip this if you're sure you know how already). There are several ways to do this but in any case the final result is "on the air" so we'll start that way and arrive quicker.

The 432 mixer

There should be no problems here. We already have a good strap line circuit that tunes below 420 and over 450 mhz and fits in a small minibox, so all we need after that is an oscillator input, a good diode and diode by-pass for 432, a tuned circuit for the *if* output on six mhz, a diode bias resistor and capacitor, and an output coupling and jack. See how simple it is?

Fig. 5 shows the schematic and **Fig. 6** the

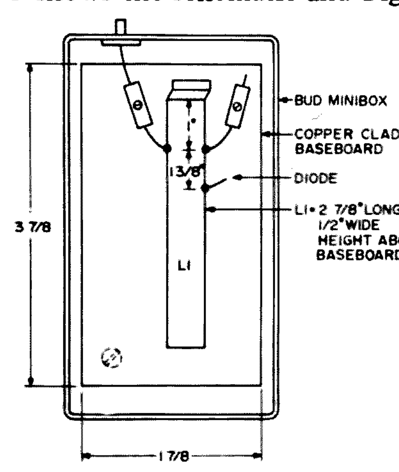


Fig. 6. Dimensions, Mixer, 432 m.c.

dimensions, which match the *rf* amplifier. With luck the oscillator will go into the same size box (it did) and we will have three small matching boxes for the *rf* head.

I have shown a dc lead (temporary) from the diode by-pass capacitor plate, C4 to J3, because this allows a fine check on the *rf* mixer section. A modulated 432 test oscillator is fed through a coax cable to the input jack and *rf* tuning and dc voltage out of the diode, with Minibox cover on and off. This is important because of oscillator harmonic mixing. This little devil has ruined many an otherwise fine home-brew project, so you'd better be aware of it. It shows up most, on six and two meters, when you start tuning up converters on the bench. That's partly what all the thousand screen rooms throughout the USA are for! Your mixer is there on the bench, no shielding (yet) and FM, VHF TV, and UHF TV all come boiling in. You're probably using a high gain *if*, most likely 455 khz. sharp, (doesn't like FM!) and of course, what with many oscillator harmonics and many TV and FM stations, you've had it! Harmonic mixing has been used, and described in the good old RCA 1500 page "Bible" on how to build receivers. The many harmonics simply act like local oscillators on higher

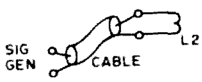


Fig. 7. Coil test set-up.

frequencies to produce, at times, a tremendous set of nuisance signals.

Fig. 7 (coil test set-up) shows how to do it in a real painless fashion. Connect your signal generator (the $30 Lafayette job is fine) through an *rf* cable to L2, solder coil leads to test terminals T1 and T2, connect a "diode plank" (Fig. 8—you *must* have one of *those*!) a microammeter, and go. I found 35 turns of No. 34 enamel, on about 3/8" diameter coil form to do the trick, with an 8/32 threaded powdered iron slug inserted for tuning. With 100 pf across the coil it tunes from 7.5 to 4.5 mhz reaching the desired 6 mhz with the slug about half way in. You can have lots of fun checking coils, Q, and slugs this way but, get on with the 432'er!

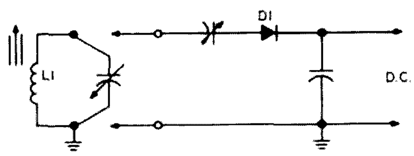


Fig. 8. "Diode plank."

Fig. 9 shows the mixer output circuit details, with two small standoff terminals holding the coil wires and C2. L3 is three turns of insulated No. 24 or 26 wound around the cold end of L2, and waxed in place with coil wax. Don't forget, all these special components you may not have on hand may be obtained in kit form (see end of article).

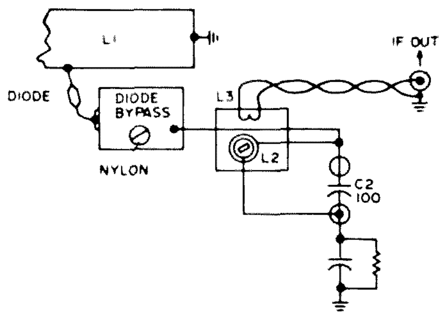


Fig. 9. Mixer output circuit details.

Have just finished assembling the mixer output circuit in the minibox and it may be tough for older eyes and fingers. But if I can do it, you should be able to also; being 64 myself right now. Of course, I've done this sort of work for many years (about 45!) and have two sets of eyeglasses, one about one and a half times magnification, the other about two times, for those really tight little spots.

Testing the mixer into a tuned *if* circuit without amplification is not an absolute necessity but sure helps as a check on the mixer conversion efficiency and getting good tuning out of the output coil. When you have a high-powered *if* running with avc it is sometimes hard to notice small differences in gain or selectivity, which can all add up, or down, together on those weak signals to come. With only a 6 mhz circuit and diode after the mixer, you *have* to get everything right such as the *rf* input, the 432 megacycle tuned circuit, the diode, its bypass, the 6 mhz diode output coil, and its output coupling. **Fig. 10** shows a test circuit good for this sort of work, with both dc and *af* outputs. Simple as ABC, useful as a pocket in a shirt and yet you still have to build it or buy a grid-dipper. If you're really going in for home-brewing, you'll need a whole slew of these covering all frequencies!

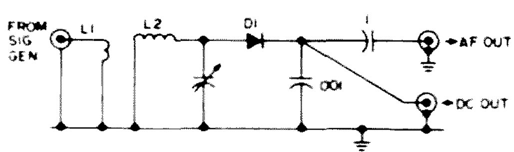


Fig. 10. Tuned diode detector with d.c. and af.

When the mixer was set up, a local oscillator and a signal generator plugged in, the *if* plugged "out," conversion to 6 mhz was soon obtained through the diode, and all circuits were peaked up. I also tried my big receiver on it and picked up the crystal controlled signal generator from way out in the field, but the non-crystal controlled L.O. was of course too jumpy for this type of operation. Check back in the first section for this item just in case you don't remember about narrow-band receivers as *if's* for tunable local oscillators on UHF.

RF local oscillator

I could breeze through this at top speed, but always there are new listeners, (there'd better be!) so skip parts you already know. After completing the assembly and tune-up I've changed my opinion. Don't skip it! With thoughts in mind of later ganging the three units (*rf* amplifier, mixer, and oscillator) this unit was made with the same baseboard, strap, and type M capacitor. Instead of the emitter being grounded as in the *rf* stage, the base is grounded putting it out of phase with the collector. This automatically makes it an oscillator except in certain extreme cases.

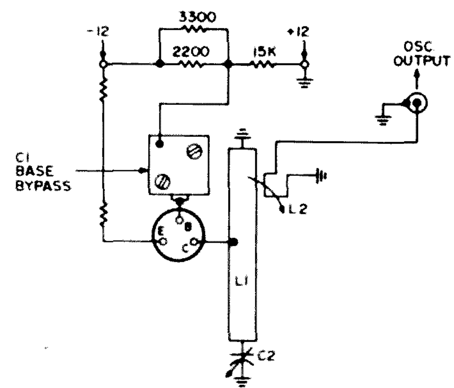


Fig. 11A. Oscillator schematic.

See **Fig. 11** (schematic) and **Fig. 11B** (dimensions). Among the things you want in a tunable *rf* local oscillator are stability and freedom from pulling, that is, as much as you can get...So, run a fair amount of power and decouple as much as possible into the mixer. Above all, have a *good* oscillator. This one worked immediately and why not? Anyone can build an oscillator, can't he? (Sometimes I can't myself. See later). I took two plates off the nine plate Johnson type "M" capacitor to put 432 in the middle of the dial, checked out the total emitter resistor needed, with an outboard pot., and that's it. Except, there were some nasty little spurious signals tuning faster than "regular" signals. These

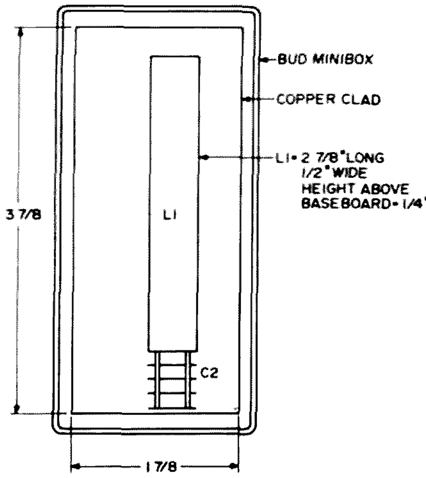


Fig. 11B. Oscillator dimensions.

little hitchhikers come in without an antenna too, which is *real* bad. Remembering the old days of a high grid leak (never mind what that was, just read on!) the base resistor was cut down a little, from 2,000 ohms to about 1,800 ohms, and the spurious vanished. I later changed the cable and coupling to the mixer and put back the 2,000 ohm resistor. In case you get this type of spurious (there are others) that base resistor is the first place to check.

The 6 mhz *if* amplifier

There is nothing too special about this unit, other than considerations of bandwidth, image, gain, freedom from oscillation, reproducability (to allow any amateur to build one), why you can't use a well-known *if* strip using 455 khz for under $5, proper avc, good *af* out, 6 mhz output tap for a low-frequency converter and narrow-band *if*, and, last but by no means least, low cost.

Going through the listed considerations in order we have: A) Bandwidth. I picked 6 mhz for the *if* frequency, giving a bandwidth of some 200 khz. I did this mainly because of my fondness for the way my good old Gonset Three acted, but it works out about right. If the bandwidth was any less, you'd have to use crystal control, if it was much more you'd begin to lose signals in the increased noise of the *if*. Of course, there are other ways to get bandwidth, like swamping resistors on the tuned circuits, etc., but this requires more stages for equal over-all gain. And, if you're going to run a narrow-band *if* after this one, you will not need *more* stages but less, at 6 mhz. You can see right now that even a "simple" *if* can get involved. We'll try and keep it short.

B) Image. At 6 mhz the image is 12 mhz away, and with two tuned circuits of half inch copper it may be enough. (It was.)

C) Gain. Three stages should carry us well into the noise region which is all the gain you need for this set. It did. D) Freedom from oscillation. Neutralization was not needed, but shielding was used. Small copper clad "walls" were installed close to the base lead of each stage, with a 3/8" hole for the base lead to go through, and this did the trick.

E) Reproducibility. This is achieved by making up coils that are easy to copy, giving detailed descriptions of how to build and test them, and laying out all components for easy checking and changing if needed.

F) You can't use a narrow-band 455 khz *if* strip with this receiver because it uses a tuned oscillator from 426 to 456 mhz, which cannot be stable enough (and low cost as well) to convert UHF signals into a low frequency, 10 khz bandwidth *if.* Later on, if you use a crystal-controlled oscillator you *can.* Again, this rig is planned to be easy to build, flexible for change and improvement, to be used along with a simple MOPA transmitter, to have fun with, mobile, hand-carried, for work across town, and who knows how far when you get two of them running. It's up to you if you add the crystal control, both in the receiver and in the transmitter. They will be described later. Don't forget that with crystal control in the receiver you will have to tune something else! And, if that something is an ac operated communication receiver, how are you going to carry it all around those mountain tops? Just a reminder.

G) AVC. This isn't too hard but there is a combination which has to be just right, so that the base bias does not put the diode detector into the wrong dc condition. All sorts of additional circuits can be used but this is planned to be an *easy* rig. So just wire it up as shown, it works well and so does the S meter which can be a simple one milliamp meter shunted down a little to read the second stage emitter current at nearly full scale. It works backwards but who cares. You can peak up beam directions and *rf* stages with it fine. H) Good audio output. This is the easiest. Just use a good diode with the right value of resistor and capacitor, plus almost any of the little Lafayette *af* amplifiers. J) The 6 mhz output is even easier. Just a link around the last stage inductor out to a jack, to be used later (perhaps) with a second mixer and narrow *if.* K) Low cost. If you already have a flock of VHF transistors that work at least at 6 mhz, some small coil forms and slugs, input and output connectors, a plank or two of copper-clad, a few capacitors and resistors, that's it. It won't cost you anything then, except maybe some of your days, and some cerebration.

Building and testing as you go

Fig. 12 shows the first *if* stage. It has lots of gain. With an antenna plugged into it, it pulls in London, etc., on the 6 mhz "short wave band." You can use almost any coil form you want because six megs is not critical but you must be sure it is tuned right. I

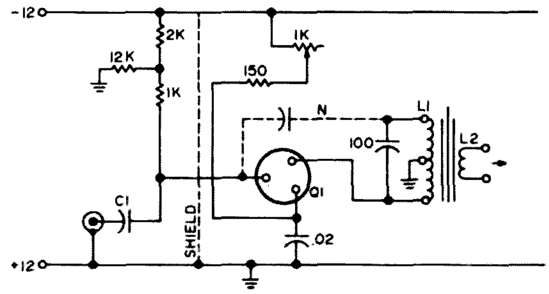


Fig. 12. First *if* stage, 6 m.c.

Parts List

L1 = 2 pi, 20 turns each, no. 30, with 6/32 threaded core.
L2 = 3 turns wound on center of L1.
N = neutralization not used. (Might be needed with other transistors.)

found the gain of the first stage to be up near 40 db with almost any of the good VHF transistors like 2n1726 and so on. It showed no sign of needing neutralization as yet so that part of the circuit is put in as a dotted line. Coil forms can be fixed iron core with leads and a ceramic trimmer, which will take a little more space; commercially available ceramic forms with movable iron core; very low cost phenolic tubing which is supposed to thread itself when you insert the core (it doesn't always do this too well so I tap them out first); or real microminiature ones.

Fig. 13 shows the second stage which worked just as well and also showed no need for neutralizing. I'm beginning to get just a little suspicious of this! Too much of a good

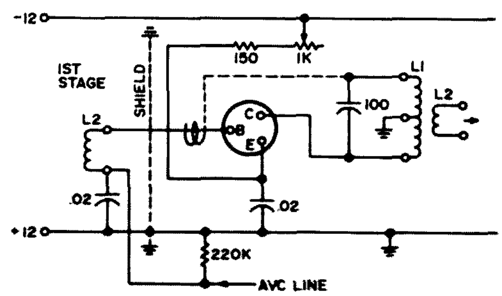


Fig. 13. Second *if* stage.

thing. The base input circuit is from L2 instead of through a capacitor. Same collector coil and circuit as the first stage.

For the third stage and diode see **Fig. 14.** Everything still going fine, with the collector coil having a larger secondary winding to the diode with ten turns instead of only three for a base input. The number of turns on this winding which feeds the diode detector and avc even though not critical, should be adjusted for best avc action and audio output. As mentioned before, you can play around with all kinds of separate avc diodes, avc amplifiers, S meter stages, etc., but let's try and keep this rig as straightforward as possible. With a two pi winding, tuned with a 6/32 threaded iron core and about 100 pf capacitor, as shown in **Fig. 14,** it works fine.

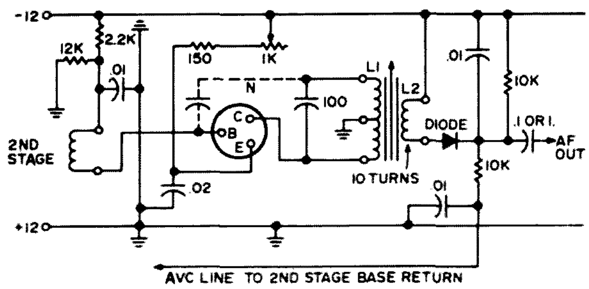


Fig. 14. Third stage, *if*, 6 m.c.

AVC

Pay attention to this item. Several little rules to watch. Do not put avc on the last *if* stage. Let it run full gain into the diode to give plenty of avc voltage. Choose a proper balance between the diode resistor R6, the avc line series resistor R6, and the bias voltage resistor R7. If you put too much dc voltage on the diode through the avc line the *af* will be distorted on low signals. If you put too much R (R6) in series with the avc line you won't get enough avc action. You could put a lot more avc action into the circuit like they do in car radios, with avc on the *rf*, the mixer, and almost everywhere, in order to help matters when you drive past those crowds of AM towers on the New Jersey flats, but you don't need that here.

With all the above details you should have a good *if* strip by now.

AF

This will be real short. Lafayette has a selection of transistor *af* amplifiers which work fine. You can get up to three watts, which is better for mobile work if you have that in mind. Get several because you'll need another one for the modulator, unless you

want to do a lot of switching between microphone and speaker, etc. You can even get three, one for the modulation checker when tuning up the transmitter. Once you use this trick, with a diode and padded earphones, plenty of *af* gain to keep your voice from getting to your ears through the air you'll never be without it. You can hear every bit of hum, distortion, etc. that can creep in, and, if everything is correct, your own voice coming to you through the mic, transmitter, and antenna just as it sounds to the lad on the other end of the QSO. With the exception of unwanted FM, if any. That is another story.

Assembly

When you finish these receiver units you will have the receiver half of a nice portable rig. I have found a simple carrying rack of plywood, with as many shelves as you need, and a dowel handle on top, sprayed with aluminum paint, to be very useful. The receiver is really very simple, just a standard superhet. It helps though to know you can plug in a crystal controlled oscillator chain and narrow band *if,* check the mixer without the *rf* stage, build more *rf* stages and add or substitute them as desired.

Leave shelf room for a modulator, transmitter, and possibly "high power" addition. Two watts? Five watts? Who knows what the future, along with a little more hard work (and $) on your part, will bring you? Mount the speaker in a little box, removable, so you can place it off the rack. Audio feedback gets to the tuner through the rack itself. Or you could use foam rubber mounting to handle that matter.

Final tune up

This can be troublesome. It was here. Quite a few cables to make up, but worth it in flexibility. 1) Antenna to *rf.* 2) *rf* to mixer. 3) Oscillator to mixer. 4) Mixer to *if.* 5) Mixer to *af.* I put two lantern batteries on the bottom shelf for a total of twelve volts, with the *af* amplifier in front; the *if* on the next shelf, and the *rf* head on the top shelf. A new and taller rack will be made up for the transmitter units later.

Checking back through the circuits you will notice cable matching input capacitors going to almost every base. Some judicious testing of cable lengths can help, because, unless you have a slotted line and do a real professional job on the SWR like when *someone else* is paying you for those extra days, be happy with a few standing waves.

A simple test signal unit with two tripler stages from a 48 mhz crystal, to 144 and then to 432, was used as a test oscillator with a nine volt transistor battery, a dipole, and a modulator, and placed about 100 feet away. Works fine but sure swamps the S meter. Then came a little glop of trouble. After all my warnings about frequency checking on multiplier frequencies, it happened to me right on my own bench. I tuned up the complete receiver, found the test signal generator on the dial, and proceeded to test the *rf,* mixer, and oscillator stages, using the full gain of the *if.* Nothing worked right, and no wonder, I had inadvertently tuned in one of the higher harmonics of the test oscillator over 500 mhz, right alongside of one of the Massachusetts UHF TV stations, and then, to make matters really sticky I had, also by mistake, peaked up the test oscillator near 525 mhz too!

On checking with an old but calibrated coax mixer, everything seemed to be over 500 megs. Which it was! Just part of the game of course, so, as I keep saying, check that frequency.

As soon as everything was put back near 432 the new job showed up as having real pulling in power. The *rf* and mixer peak up nicely, and the oscillator is quite stable.

With the front end as described in the text and figures, it is quite easy to get too much oscillator voltage into the mixer. Oscillator harmonics will then show up as CW signals, but tuning much faster on the dial, because when you move a megacycle at 432 the harmonic may move two or three. Reducing coupling into the mixer by either the capacitor or the oscillator link, or both, cures this. You don't need that much signal for a local oscillator.

Listening in a little

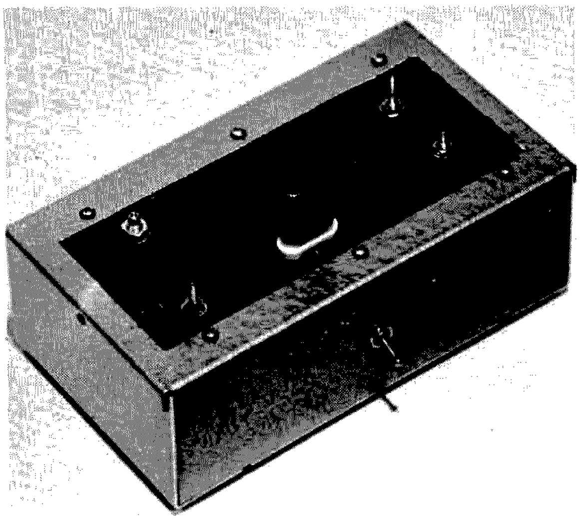
If you hear a strange humming noise, going up and down in volume, tuning very broadly, near 420, and again maybe near 500 mhz, shut off the rig, go outside the house, and listen for a big plane. It's one of those altimeters!

This was just an indoor antenna test before putting up the big beam outside. Also heard were the Mass. TV station on 425 mhz and a very loud pulse signal on about 430. It will be very interesting to see just how far two rigs like this will be able to maintain QSO's.

All I need now is that matching transmitter.

...K1CLL

6-Meter FET Converter



William Deane, W6RET
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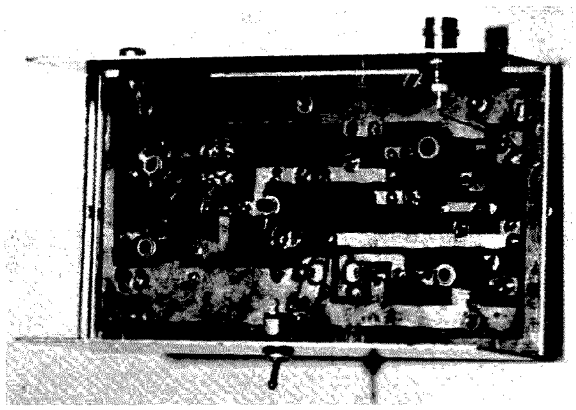
Recently there have been a number of interesting articles in the various amateur radio magazines describing the Field Effect Transistor (FET). The purpose of this article is to describe a simple and practical FET 6 meter converter. As you may know, the FET combines some of the best features of the vacuum tube and transistor and is rapidly being used in many new electronic circuits. FET's are divided into two main groups: the junction FET and the insulated gate FET. New terminology has been introduced to designate the FET terminal connections. They are the Source (cathode), Drain (plate) and the Gate (grid). The junction FET was selected for this converter to simplify the construction. This is possible as the Source and Drain are interchangeable in the JFET. The determination of which element is the Source or Drain depends upon the applied voltage.

The schematic of the converter is shown in **Fig. 1**. Three Texas Instrument TIS-34 FET transistors are used. These transistors are available for a $1.10. T1 is the *rf* amplifier, T2 is the mixer and T3 is the crystal oscillator. Note the similarity to a vacuum tube circuit with the Gate (grid) and Source (cathode) resistors and the Drain (plate) connected to the tuned circuit. No fancy biasing circuits are required. Although a standard transistor can be used in the oscillator circuit the simplicity of the FET oscillator is unique. The 50 MHz incoming signal is mixed with the 36 MHz signal from the crystal oscillator resulting in a 14 MHz output signal. In the crystal controlled type converter the receiver acts as a variable *if*. If used with the Collins "S" line, for example, you will be able to cover 50 to 50.4 MHz of the 6 meter band by tuning the receiver from 14 to 14.4 MHz. If you have a general coverage receiver you can tune the entire 6 meter band.



Bottom view of the converter shows the antenna coils L1 and L2 at the top of the photograph, with L3 in the center and L4 and L5 output coil at the bottom.

The photographs show the general layout and construction technique used. The converter is constructed on a 3 X 5¾ inch printed circuit board. If you have not had experience with printed circuit boards this will offer you an opportunity to try your hand. Small inexpensive kits for etching copper circuit boards are available at most radio stores and mail order electronic firms. The actual process is not too difficult for the average ham. **Fig. 2** is the layout of the board. Slight deviations or other arrange-

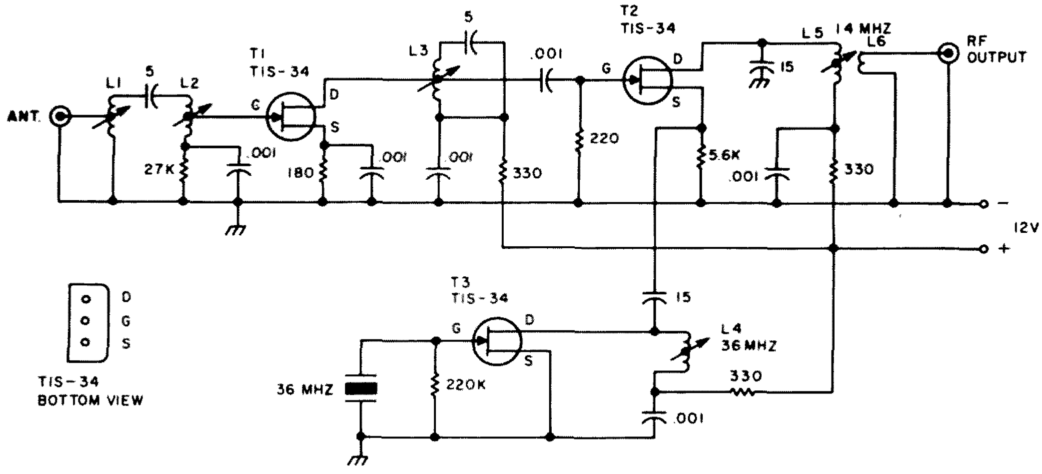


Fig. 1. Schematic of the 6 meter FET converter.

Coil Data

L1 - 10T #2BEC CW ¼" tuned form tap at 2T.
L2 - Same as L1 tap at 4T.
L3 - 8T #28 CW-tap at 4T ¼" form.
L4 - 16T #28 CW ¼" form.
L5 - 40T #28 CW 5/16" form.
L6 - 2T small hookup wire.

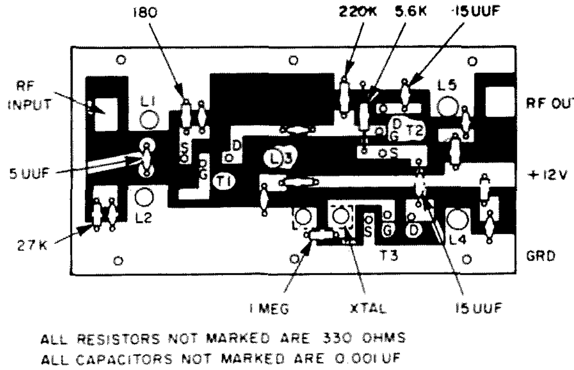


Fig. 2. Layout of PC Board.

ments can be made. I find it best to draw the layout on the copper side of the board in pencil and then fill in those portions of the circuit board to be retained with the resist paint supplied in the kit. Actually any type of model airplane paint works quite satisfactorily. The pc board is next placed in a small plastic or glass container and covered with the etching solution. (Not used in all kits.) The etching process takes 20 to 30 minutes, during which time the solution should be agitated by rocking the plastic container back and forth. When the etching process is completed the board is washed with water.

Following the etching process the resist paint may be removed with lacquer thinner or carefully scraped from the board. After the paint is removed, the board should be cleaned with steel wool or fine sandpaper. After the board is cleaned the resistors and condensers can be mounted as indicated in Fig. 2. The transistors, crystal socket and coils are then mounted. As mentioned previously, the Drain and Source are interchangeable so you don't have to worry how the transistors are installed as long as the Gate is connected to the proper terminal. The transistors require a supply of 12 volts dc. This can be obtained from a small battery pack or a standard 12 volt power supply. The unit requires 18 mA. If intermittent use is contemplated the battery pack will be satisfactory, but if you plan to have the unit on for long periods of time, a standard power supply is suggested. The unit is mounted in a small chassis box 6 1/4 x 3 1/2 x 2 1/8.

With the unit connected to the receiver, antenna and power supply, the coils can be adjusted for maximum noise in the receiver. This should allow the reception of signals and the coils can be peaked on the receiver "S" meter. In some areas channel 2 may cause some interference. If this is a problem in your area, a tuned circuit consisting of a 45pF trimmer and 5 turn coil ¼ inch in diameter can be installed between the rf input and the antenna jack to trap out the channel 2 signal. My thanks to Don Bidwell, for his photographs of the converter.

...W6RET

Robert L. Grenell, ex W8RHR
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Compleat AVC

If it's worth and hour and a half of enjoyable labor and $5.00 worth of new parts to make a dramatic improvement in your receiver, heat up the soldering iron, pull off the cabinet and get to work!

One of my failings as a homebrewer is my tendency to modify and reuild my projects in occasionally successful efforts to improve their performance. The pursuit of excellence, and all that, you know. As a consequence, very few of my projects are ever totally completed. Take the avc circuit I described in conjunction with a product detector in a previous article. It was simple and worked beautifully . . . permitted overload only on the strongest local signals. But after a few weeks, I had to admit that the output of my 75A2 fluctuated just a little bit too much for really comfortable reception. The only answer was dc amplification of the avc voltage, a feature which was originally included in the receiver, but which I removed in developing the audio-derived

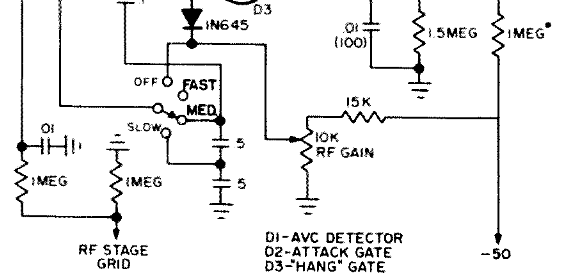

Fig. 1. Values shown in parentheses are to be used when deriving control voltage from the last *if* stage. *See text.

avc circuitry. I did not feel that the original circuit was very effective, or I'd never have removed it, so rather than replace it and try to improve it, I decided to start from scratch.

The result is the circuit shown in **Fig. 1**. It features dc amplification, voltage delay, fast attack and slow decay, and handles a wider dynamic range of signals than you'll find on the air. Detector overload is eliminated altogether. I have shown the whole avc system for a good reason: It is, in the strictest sense of the word, a *system*. Its performance and specifications depend on the proper relationships among all the components. If you build up the dc amplifier and try to stick it on your avc line, results may not be satisfactory. So if you're going to do it, go the route, or not at all.

I tried this circuit deriving control voltage from both audio and *if* signals with about equal success. Should you decide on the latter, it will be desirable to reduce the values of the input and filter capacitors as shown in **Fig. 1** for optimum performance. Also, it is more effective to take the signal from the primary of the last *if* transformer than from the secondary.

I chose a 6T8 for the convenience of having all the necessary elements in one package, thus eliminating several tie points and terminal strips. Depending on the physical set up of your receiver, you may wish to use a 6AV6 or 6AT6 with a silicon diode for the "hang" gate. Perhaps you can use half of a 12AX7 or other high-mu triode with germanium diodes for the avc detector and attack gate. Another important factor is the availability of proper B+ and negative bias voltages. The value of the cathode load resistor can be changed to accomodate different voltages, but B+ should not be less than 180 volts, and the bias should be -50 volts or better if you want to take full

advantage of this system's capabilities. If your voltages are radically different, the value of the cathode resistor should be varied to achieve the best compromise between satisfactory voltage delay and effective avc action. The purpose of the voltage delay is, of course, to prevent avc action on weak signals, permitting maximum sensitivity until a certain signal level is reached.

The operation of the circuit is quite simple. On weak signals, the rectified signal voltage is not great enough to overcome the positive voltage in the grid circuit, so no avc voltage is developed. When the rectified signal voltage exceeds the positive voltage, the triode is biased in the direction of cut-off, the cathode goes negative in proportion to the signal strength, the attack gate is forward biased, and a proportional degree of the negative bias is applied to the avc line through the "hang" gate. Should the rectified signal voltage be great enough (as when operating full break-in), the triode will cut off, and full bias voltage will be applied to the avc line, muting the receiver.

An additional form of delay is introduced by the voltage divider through which the avc voltage is applied to the *rf* stage. This keeps the sensitivity of the *rf* stage high enough to preserve a satisfactory signal-to-noise ratio on moderately weak signals which activate the avc but need some "help". This is not a technique to correct a design flaw, but rather allows the avc to act early enough to maintain satisfactory control over the output level without masking the signals in noise. Of course, as has been pointed out, on weak signals, no avc voltage is applied at all.

The divider sets the decay time constants of the system. As it is shown in Fig. 1, decay times of 140 milliseconds, 500 milliseconds, and 1 second are provided in the Fast, Medium and Slow positions respectively. Attack time is less than 75 milliseconds in any position.

RF gain control is achieved by biasing the avc line through a silicon diode, which prevents further loading of the line. The diode is reverse biased until the negative voltage applied through the *rf* gain control exceeds the avc voltage, so the control has no effect until that point. Beyond that point, the avc is inoperative unless an extremely strong signal would cause the avc voltage to exceed the *rf* gain bias. This would, or course, reverse bias the diode again, permitting the avc to take control. This method of control offers some interesting possibilities. Turning the avc switch to the off position bypasses the diode, loading the avc line heavily enough that the avc voltage is "killed". After you've used this system for a while, you'll probably find that you never have occasion to use the *rf* gain control at all. I guarantee, this is one avc that will be left on.

The superiority of this system is evident. As installed in my 75A2, it holds the output within 6 db on *all* signals, and I have yet to encounter any signal strong enough to overload either the AM detector or the product detector. Because of the delay, weak signal work on 6 meters is greatly facilitated. Signal levels which previously would not yield copy now give Q-5 copy, in many cases.

One final word . . . a high noise level can render the delay function of the system completely ineffective. However, the great benefits of amplified avc action are no disturbed. A good *if* noise blanker will make it possible to derive the full benefit of this avc system, and you should definitely consider adding this feature to your receiver. I'm presently developing a simple blanker, and when it's finished, *73* will be the first to know.

. . . W8RHR

Leaky Lines

There's been a great deal of favorable comment about a newly formed net on 7255, called ECARS (East Coast Amateur Radio Service.) Evidently patterned after MWARS and WCARS, its prime purpose is to assist mobiles with traffic and weather information, run phone patches and so forth. I've sat in about a dozen times, and can report that for a new net it's doing a first class job. Membership is being formed up, with current rolls up to about 350 members, and they print a monitor which will be sent to all members. For information about joining, I suggest you listen, or better still, check in. This net looks like a winner, and I believe it will be around a long time. It starts around 6:30 A.M., EST, daily and goes till unconscious, as the saying goes. How about joining in on the action?

*

They had a really great turnout at the Harrison Sideband shindig, at the Statler-Hilton in New York. I saw lots of old buddies, and had a swell time, just roaming around. I gave them a start; they didn't expect me to walk in with a growth of chin whiskers. I sure got the horse laugh from a few of them, but that's okay. My beautiful Penny said she likes it, and that's good enough for me.

*

I missed the North Jersey DX Association's annual round-up. I had a prior engagement, unfortunately. I was sorry to miss it, as it's always a ball being there. Next year I'll make sure to keep the date clear.

*

No doubt, by this time, you are all aware that our peerless and redoubtable editor, Kayla, W2EMV, is getting hitched to Doc Hale, K4MWS, and is leaving the magazine for a life of connubial bliss down in sunny Florida, the Land of the Laughing Dollar. After 22 months of Dublin, New Hampshire's ubiquitous snowstorms, she is indubitably looking forward to the warmth of the tropics, and a life of soft ease, under the palm trees. I predict, however, that she won't forsake her Smith-Corona for long, and will be re-appearing in print from time to time. Congratulations, Doc, and much joy and happiness to you both, Kayla.

*

I'm soon going to be trying to work the repeaters on 2 meters, with a little NBFM rig, through the kindness of Chuck Bell, K3HHP. I don't know how much of this activity goes on up this way, but in some areas they're having a whale of a time with it. I should think that our hf bands will profit greatly with the burgeoning opportunities afforded by these vhf repeaters. A lot of qrm will disappear, and that's all to the good. I think that somebody with experience in the repeater field should write a piece about it. What say, somebody?

*

I've been carrying on a campaign, with the tacit approval and blessings of many others, to stop the idiotic use of meaningless drivel on the air.

When someone asks for my handle, I usually answer, "The handle is broken off; my name is Dave." I never, but never, say qth, Queen Roger Nancy, H..I... or even 73. Why use all this CW parlance when we have a perfectly usable language with which to express ourselves? Boring and trite at best, it gets to be moronic when poor band conditions do not necessitate its use.

By far, though, my pet peeve is the nauseating use of the royal or editorial first person plural. When a guy says, "we" or "us" in place of "I" or "me," I always ask him if he is a Siamese Twin, or if he has two heads. This practice sickens me. By the way, we all know what a linear amplifier is, but would someone please tell me: what's a linear?

Here's a commonly heard stupidity. A net is in session, passing traffic. Or perhaps it's a round table, just chewing the rag. All of a sudden, out of the clear blue sky, without so much as a "By your leave," someone interrupts the proceedings with an urgent sounding, "Break, break, break, break." At this point, of course, realizing that something imperative in the voice of the breaker commands immediate recognition; perhaps a catastrophe of unthinkable proportions has occurred, the NCS, or one of the rag chewers calls in the station.

I must add an editorial aside at this point. Fellows who wouldn't dream of sitting down at your table in a restaurant, or getting into your automobile uninvited, have no hesitancy about rudely interposing their unwelcome presence into a private conversation on the air. Just plain rude, that's all.

Well, anyway, the station is called in, since the occupants of the frequency are eager to render assistance to the emergency breaker. The following transmission, incredible though it may be, is what they hear.

"Fine business, Old Man. The handle here is Ignatz....Ignatz....Idiot, garbage, nosebleed, alimony, termite, zilch....Ignatz. Our qth here is Split Lip, Calichussetts. We just put a doo-hickey on our frammis here, by golly, and we wonder if you could give us a signal and audio report. By the way, Old Man, by golly, the rig here is a Duck, and the old hearing aid is a Goose. The sky wire is a double-whammy super Mark seven quadrical cube pointing in your general direction, Northeast by Southwest. Our linear is a Swinette, in grounded grid, with a dixie-cup readout. It's been doing a fine-business job for us, by golly. So whatsay, Old Man, how copy, H...I...break, break. Ooooooohhhhhh-ver!"

Well, what are you going to say to a jerk like that? I mean to guys like those? I mean...oh, the hell with it. He had more we's than a men's room. All that was missing was, "That's a big ten-four!"

Wait till I get to the guys who give you this: "See ya down the old electric light bill." And the big mouths who say, "From the beautiful snow-capped, sun drenched hills overlooking the peaceful valley of the Fugahwi Mountains, this is the voice of Penwiper, Pennsyltucky, saying, the very best of seventy-threes, seventy-sixes and eighty-eights, Old Man. May the bluebird of happiness light on your windowsill every morning, and may the old master brass pounder in the sky take a liking to you; and till we meet again, aloha, au revoir, auf wiedersehen, hasta la vista, and a rividerci, Old Man. Dit...Dit..." Oh, brother!

I wish that stations would refrain from calling DX stations on their own transmitting frequency. Lately, despite repeated entreaties to listen five or ten up, some guys insist on clobbering the DX in this fashion. It makes things rough for everybody, and certainly doesn't do the offender any good either. The best procedure is to listen to the DX operator, and follow his instructions, whatever they may be.

By the way, it is not legal to go down into the foreign portion to explain to another foreign ham that he is interfering and should change frequency, for when we do this, we are merely compounding the problem by adding to the interference. Plus

that. it's an open invitation to the FCC for a nice little pink slip.

There's been some discussion of late about broadbanding 75/80 meter dipoles. Quite a few lads and lasses like to work both the phone and CW segments, but have neither the space nor the inclination to put up two wires, nor do they desire the addition of a matchbox or L network, or other type impedance-adjusting device.

The Collins people once had an interesting configuration in one of their manuals. I believe it has been called a fan dipole. An extra length of conductor is soldered in at each side right at the feed points, then fanned out in a horizontal plane. The spacing at the ends is anywhere between five and twelve feet, depending upon available space. The resonant point is somewhat lower, so that the entire antenna must be shortened for a given frequency. This is, for all practical purposes, a section of a discone. I'm told that it effectively broadbands the dipole so that the entire 500 khz of the band may used, with pretty flat vwsr. Worth a try? I think so too.

I can't recall anything which has given me greater pleasure than the letters in April's QST, in response to the February editorial. For a long time it has been evident that hams are a heckuva lot smarter than some folks think. They are very much more aware of things than they are credited for, and their knowledge is not restricted to radio and electronics. They resent, rightfully, any efforts to limit their freedoms, just as any other citizen would. Especially resented is any idea that somebody else, because he holds some title or office, is fitted to decide such limits. Americans, by tradition, have respect for high office, but this does not mean that they automatically respect men who hold such office. They do not regard officials with any particular reverence. This very Republic was founded in the crucible of irreverence for autocratic authoritarianism, as exemplified by the British Crown, and it goes against our grain to accept with bland docility any type of dictatorial censorship against the free expression of opinion. In fact, in America, one of our most important traditions is the right to express unpopular opinions. And the degree of freedom which we enjoy, unique in all the world, is gauged precisely by the right of the individual to stand alone in an unpopular opinion, though he were opposed by all the rest of us. We regard that right as something sacred.

The letters which were printed, (and I can only gather by the huge proportion against the editorial, that there were very few letters for it,) clearly showed a high degree of understanding, were articulate and to the point. There is no question that hams are well-informed, involved persons, determined to safeguard their rights and Constitutional privileges against any incursion, whether from outside or within our own group. They understand the bankruptcy of the vigilantism proposed by the editorial. They recognize the folly of committing suicide to keep from being killed.

It is very clear that very few hams are about to accept a "Big Brother" with a proposal for self-appointed thought police, no matter how sacrosanct his position or office. Those letters in QST express more honest-to-goodness Americanism than a dozen civics text books. Makes me feel proud, when I realize the intellectual capacity of my colleagues in Amateur Radio.

Dave Mann, K2AGZ

Field Day Fever

Alan Shawsmith, VK4SS
35 Whynot Street
West End, Brisbane
Queens, Australia

Man, was I in double trouble. It was a long week-end. The kids were away with their grandparents at the beach. In an early morning, clear and mild, the YF and I were at breakfast on the sun porch. All should have been serene and happy. But, not so.

I had disgraced myself the night before, but that was not the end of it. I had made away from home plans without telling my OG. We all know what that means, particularly as she was planning a party and had been slaving these past two days to bring the house to its best.

Jadedly, I knocked the top off a boiled egg. My spirit seemed about the same as its contents; weak and soft.

I gazed across the table at the Nephritete-like head of my beloved and wondered at my devotion all these years. The shiny black hair tumbled as she bent over the morning paper, reading me the headlines.

"Drug running now big business off the East Australian coast. Racketeers continue to elude patrols."

"Do you think they use radio?" she asked.

"Who?"

"The dope smugglers."

"Yes, almost surely."

But my mind was on the week-end plans. How could I manage to tell her, especially after last night? I finished the egg, toast and coffee and felt a little more virile.

Every married male might be the man around the house, but the *subtle* master is the mistress of it. In my case, should I threaten to step out of line, I was given the "ego boosting" treatment. A sort of confidence trick it is really. With a meaningful look from the XYL's gypsy-like eyes, I am reminded every so often that I am a gentleman. How could I ever be unethical. Thus my will is imprisoned and conduct assured.

But this morning the male was about to roar. I *was* going away for the week-end, because arrangements had been made, even if they were concluded through a slightly inebriated haze, the night before.

"Honey," I said in a voice that was meant to be quietly final, but in effect came out weak and pathetic.

"Forget about the party tonight. I want to take you away for the next few days."

There was no immediate reply. Then she raised her head and looked past me into the kitchen.

"What are you going to do about *those*?"

"Ah yes, *those*." Oh my shame, I must explain.

Last night, leaving the pub after my quota of a quick two, I ran into Harry Watermaine. Field Day fever possessed him. (Actually I had forgotten about the event.)

"Say," he enthused. "I know of a DX Utopia. The perfect QTH. Optimum angle of radiation and everything is S9 plus. I'm taking the car and caravan. You must come."

Each succeeding beer made the idea seem rosier. It was late at night before the final details were settled and I could hardly wait.

Unsteadily creeping up the front porch steps, I knocked over a milk bottle. End over end, it went shattering the quiet.

"Shh, shh," I hissed, "You'll wake the YF."

"Where the heck is the door key." Why does a man need so many pockets. Top and bottom, back and front, inside and out. Eventually, it was located but a lot of 10 and 20 cent pieces were spilled in the fumbling process. "Never mind, I'll retrieve all in the morning."

I awoke with the expected. Headache and heartburn and my excesses demanded I rise immediately. Foggily the loose change on the porch came to mind. Unsteadily I opened the door and stepped back in amazement. The silver money was gone but in lieu, stacked phlanx-like, were 27 bottles of milk. Surprise quickly gave way to irritable temper. "A smart-alec milkman," I mused. What a cheap piece of petty capitalistic exploitation. Then through my misty hangover the ridicu-

lous began to dawn. Tottering back to bed I burst into a loud guffaw of laughter.

Sleepily, the YF opened her eyes and regarded my mirth suspiciously.

"Sweetheart, is there any rum in the fridge?"

"No. Why, haven't you finished yet?"

"Ha, ha, ha. Where's the cat?" This brought her bolt upright.

"How should I know. Are you all right? What's so funny?"

"Like a bath in cow's juice?"

Disbelief crowded into the half-awake face.

"You're nuts—or in the DT's," she said.

"Aw, fair go kid. I'm okay. That smart Charley of a milkman just sold me 27 bottles of milk."

This was too much for my Helen. She fell back and pulled the bedclothes up over her ears.

"Go and have a cold shower—and shut up," came the muffled voice.

*****

So, now I suggested we put all those bottles in the freezer until our return. "From where—and with whom?" The YF challenged coldly.

Remembering her planned party, I prepared myself for the ego build-up bit. "Up to the Lost World country. It's AR Field Day tomorrow. Monty Watermaine is taking his gear—and us."

"NO."

"Aw gee, Honey," I pleaded. "Field Day only comes once a year. We can hold a barbecue anytime."

"The party's off. When you didn't come home last night, I rang no one. A trip to the mountains is okay—but not with 'Gusher'." (This is Monty's nickname. Aptly tagged because his effacious manner irrates most of his friends.)

"No," she insisted. "Not with that arty eccentric. Besides you only want me along as a char. While you two drool over the rig, I'm the one to attend your creature comforts—or act as a rigger on the sky hook."

She banged the newspaper on the table in one of those small transitory piques, I had come to know so well.

"Look my Sweet," I implored again. "This is a chance too good to miss. Monty has found a DX Eldorado. You know, a place where reception is super dooper. All sigs S9 plus."

"Why Gush—and how did he locate it?"

"Oh well, he paints you know and seeks out virgin country for his landscapes. Sometimes he takes a radio along."

"Rings phoney."

At that moment, there was a mounting roar from outside.

"Oh that'll be the pantechnicon for the Hunter's. They're moving you know. One more TV griper off your back, eh? I must wish them good-bye."

I let the barb pass and stared miserably at the vibrating dishes. The milk bottles tinkled in sympathy. My heart rose in my throat and what courage I have trickled into my slippers.

She was back in a second; wide-eyed.

"Hey, it's Gusher and he's towing a railway carriage."

"It's his caravan," I said feebly.

"Where did he buy it—from a circus or the Government?"

"No, it's homebrew."

"It's like a tired daschund. Sags in the middle. Who painted it?"

"He did."

"Why so monstrous?"

"He uses it for his art besides AR. Has a piano in it too. He plays you know."

"A black square Buick and a tangerine and mauve caravan. Ye Gods."

"...and the interior is psychedellic," I snapped irritably.

"How could I drive away from here in that?"

"Shame. Where's your integrity?" It was my turn now.

"Monty," I called from the door, "won't be long."

In the bedroom the YF was camouflaging herself behind dark sunglasses and a large bandana.

"I can see," she said, "that if I care for your safety, I have no choice other than to come along and protect a couple of fools from themselves."

I sighed deeply.

*****

It is best to draw a veil over the trip to the mountains. We eventually made it, but the fates must have been in a benevolent mood. Enroute, a service station pad was cleared to allow us to draw in and fill up. The proprietor was paid for his pains by Monty driving off with most of the stations advertising bunting. Off the main road the Buick's brakes weren't up to a sudden stop and we nearly removed a farmer's cattle gate by flattening it; and a mile further on, the caravan's radio aerial sliced off someone's telephone wires. After several stops to allow the old bomb's

gasping, wheezing motor to cool down and recover its strength, we suddenly emerged from a tropical rain forest, out on to an elevated plateau. A magnificent panorama surrounded us. Behind were the towering mountain peaks, and away below, now hazy in the fading light ran the ribbon of coastline. A white string between purple Pacific ocean and lush green vegetation. But even up here human habitation was apparent. Well-tended banana plantations nestled against the slopes.

"Monty," I said softly. "This splendor humbles me."

But Gusher was impatient to test his theory and in no mood for philosophy. Besides, he'd been here before.

"See that Flying Fox just there. It's about half a mile long. What a great long wire antenna, if I swing a bare wire over it for a lead in. No one will be using it over this week-end." (A Flying Fox in this part of the world* is a long cable or wire, strung from one elevation to a lower one, down which bananas and crates, etc., are slung to a central point. A great manpower saver.)

"Okay," I said, "it's your gear—go ahead."

Monty deftly weighted his lead-in with a stone and skillfully threw it so that it wound around the Flying Fox.

"Boy Scout days," he smiled at my admiration. "Let's have a listen first up and see—Wow."

He threw the wire from his hand. "That's HOT—it burnt me."

He sniffed a forefinger. "Yep, that wire's got *rf* on it."

"Impossible," I said, gingerly testing it. "See—nothing. The altitude's got you," I ribbed.

"Well, let's go in and tie it to the receiver."

The set was barely warming up, when a harsh, distorted voice crackled through the speaker.

"—use alternative rendezvous at 03. Two drops."

The S meter was slammed hard against the pin. Monty frantically wound back the controls.

"What was that? What frequency?" I asked surprised.

"Well the receiver was on 28 mcs but it was all over the dial. It could only be a local sig. Probably outside the ham band because the image rejection in this ole set is crook at 30 mcs."

Suddenly it came again. This time the full text.

**Queensland, Australia*

"Z1, Z1. Traps trolling the reef. Use alternative rendezvous. 03. Two drops. Use caution. Confirm."

Monty reached over and touched the aerial.

"Yep, that Fox is being used as an *rf* line, for sure."

We left the receiver running and sat in hopeful silence for something further, but nothing eventuated. We began to speculate on it's significance.

"The Fox disappears into those trees down there," I observed.

Helen, my YF, said, "If I know my geography, the only reef east of here is Shark Reef, and the newspapers have been saying it is a likely spot for dropping contraband."

"Let's examine the message some more," I said. "Traps in criminal vernacular means the police or the law. 'Trolling' is patroling. '03' is most likely 3 a.m. East Australian Time, and 'two drops,' two packages or containers."

"Put like that, it sounds ominous, but couldn't there be quite a simple explanation. Maybe it's just a message for fishermen somewhere?"

"What, so far from the coast and not showing a proper aerial?"

"Who'd look for a drug gang up here," Helen said.

"Aw heck, let's ignore it. We came up here to test this QTH and work DX, so why worry about it. I can sling up a Ground Plane in ten minutes. I've got a tri-bander pre-cut stowed here in the caravan." Field Day fever still gripped Monty and he was itching to get into the thick of things.

"There's a law that says every citizen is duty-bound to report any criminal act or what appears to be an irregularity," Helen said.

My YF was at it again, setting me up. Her eyes were directly on me and the meaning clear.

"If we report this and it turns out to be authentic, we'll look like a trio of nosy irresponsibles with red faces," I cautioned.

All sat silent, ruminating. Finally, I said, "If anything is to be done, it must be now as 03 EAST is only hours away. Will that ex-disposals TX work Monty—and on the small ships base frequency?"

"I'll try it and see."

The set-up in the caravan was a wonder to behold. Being unmarried, Monty could afford to indulge himself. His gear was a mixture of new and old. The TX in mention had general coverage.

"We'll load it into the short vertical on the caravan roof," explained Gusher.

"Honey," I beckoned, passing her a pencil. "I'm going to try and contact a base station north of here. I want you to take down the text of what passes both ways–for the record."

In response to my first call, back came the reply. "You're loud and clear. Have you a message?"

The text of what we had picked was passed and the request was made, that if the message lacked authenticity, please pass to the proper authorities. After identification, we signed off–quickly.

"Probably think we're the phoney's," Monty voiced the guilt within us all. "We've just operated outside the limits of our license."

"Yes, but with good intentions."

"–which may be hard to prove. What if the sender of that message picked up our transmission?"

The YF interposed. "He's either laughing his head off at a couple of silly hams–or if we've hit the jackpot, slipping a slug or two into his shoulder gun and coming to find us."

"Please, Helen," I demurred, "don't be so sinister. You make it sound like a TV movie."

A sort of frustrated, embarrassed silence descended upon us as if *we* were the wrongdoers. We had done ourselves as far as Field Day activity was concerned. All that was left was to pack up Arab-style and fade into the night.

Defeated, I went to the caravan door and looked down into the night to where the Flying Fox disappeared into a clump of trees. It all seemed so unlikely that I began to feel we were the victims of altitude hallucinations. But worst of all, I had spoiled Monty's week-end. So, with the question of the site as a DX Utopia still unresolved, we set the old Buick moving at it's lowest possible revs and crept off the plateau on top of the Lost World and began our descent into the mists and vapors of the heavily scented rain forests. Unbridled imagination is truly a bolting horse. On every bend I expected to see a road block and a couple of characters standing in our path. The sight of the highway back to town brought a big sigh of relief.

Back home, the noise of our tired arrival probably woke the neighbors but even the YF was too travel-weary to worry.

"Stay and have a kip," I invited Monty. "You look dead beat Om."

"Me too," yawned Helen.

*****

The sound of the piano being played brought me out from the last layers of sleep.

Must be Gusher keeping his hand in. Whew, it was hot. Must be late in the day.

The OW breezed into the room. Refreshed, prim and pert. I could see immediately by her eyes that something was up.

"Log," she accused. "We tried to tell you the news earlier, but stirring a dugong from its sleep is impossible. So we just let you be."

"Wa-ssat? Er–thanks. Oh, what news?"

"Gusher, will we tell him or leave it to the reporters?"

"–reporters?" I was now on my feet. She pushed me down again.

"We scored a bullseye. They've picked up some of the smuggling gang and expect to arrest others. The newspapers want to interview you and Monty."

The weight of sleepiness vanished. "What? Great, great! When are they coming?"

"You'd better get dressed because we're having a party tonight. May as well cap our little achievement with a little get together. Monty's staying to play piano."

"That message?" I said curiously. "It was rather vague. Fair dinkum did–?"

"Yep, caught 'em red-handed, and it seems like the credit's yours and Monty's. Appears the drug runners were able to obtain prior info on the patrol's movements but we settled that."

Life suddenly seemed warm and rich, like a perfect spring day–or nearly so. There was still the matter of the bottles of milk.

*****

The time was 3:30 a.m., and the last guest had bid his farewell. What a wonderful evening! Monty's skillful fingers had charmed away the irritation his mannerisms had caused the YF. We had enjoyed the wit and humor of friends, my beloved's wonderful cuisine, and the radio news flash of our little drama up on the Lost World.

Helen appeared with the last edition paper in hand and bounding with impish mischief. Opening the fridge she peeked in at the milk bottles–all 27 of them, then came close and slipped her arms around my neck.

"Darling," she said, "there are times when you are magnificent–LOOK."

She waved the paper under my nose. It's headlines read: *"Milk Strike. No Deliveries for 4 or 5 Days."*

She chuckled, I laughed. We both laughed and laughed.

...VK4SS

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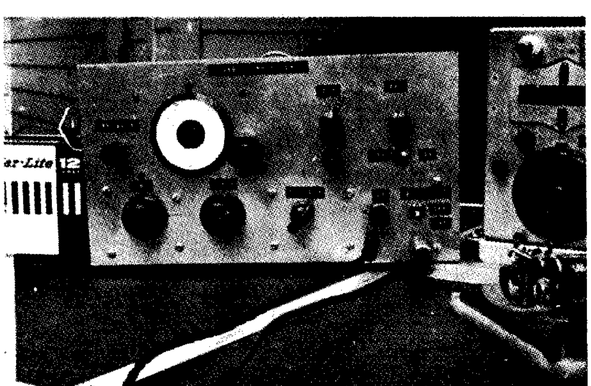
A Field Day to Remember

Fascinating, frustrating, or fun, Field Days are good tests of amateurs' engineering and operating ability. Although I had helped with two Field Days, I had done little operating because the other operators were 40-wpm men with contest experience. My contributions had been to design the antennas and to "supervise". This spring two 15-year-old Novices, Dave, WN8WMV, and Ron, WN8WMR, decided that we ought to have a Field Day. The new rules looked interesting, but there seemed to be too little time. Lack of success in building transistor transmitters had discouraged me, and I was very busy. However, Ron and Dave were persistent in their "encouragement", and I said we would have a Field Day, if we could get ready in time. My "Field Day receiver", built in 1966 as part of a "mental conversion" from tube to transistor thinking was designed for operation on 80 and 40 meters. It works well, is stable, and selective. We were determined to have battery operation for that 1.5 battery multiplier. We also wanted to have a ten-watt CW transmitter so that our power multiplier would be four. At this point, a "little bit of luck" intervened. I was given a 6-volt vibrapack that would put out 300 volts dc.

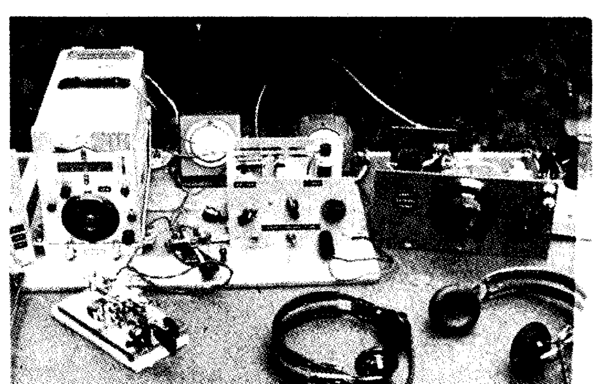
Flash! Idea! A tube transmitter! Perhaps one or two Command transmitters converted to 6-volt tubes might work. More luck! George, K8APT, donated a car transmitter from which two coils and a variable condenser had been removed. (The transmitter had a 5763 crystal oscillator and a 2E26 amplifier in a circuit taken from the 1959 ARRL Handbook.) The variable condenser was replaced, and two slug tuned coils were wound that could be tuned to resonance in both the 80 and 40-meter bands. The heaters were re-wired for six volts, and we had a transmitter. Would the vibrapack run it? Yes! Could the power be held down to ten watts? Yes! The vibrapack had a switch to change its output voltage. How about a vfo? A modified BC-457A Command transmitter with a 6J5 tube in place of the 1626 oscillator tube and with a shielded wire from the grid pin of one of the 1625 tube sockets to the car transmitter's crystal socket, provided a stable vfo. Break in? Yes! By mounting a VR-90 voltage regulator tube on the vibrapack to control the oscillator voltage, and by keying the whole transmitter in the B- lead, break-in was possible. The transmitter combination had a very good note and was remarkably free from chirps. The vfo and car transmitter were mounted on a board along with a telegraph key, a voltmeter, and a milliammeter so that the power input to the final could be calculated at all times.

With a receiver, a transmitter, and 6-volt storage batteries, all that was now needed were some operators, an antenna, a means of charging the batteries, permission to use River Rouge Park, a tent, and a few other items such as suitable lamps, tables, chairs, etc.

Ron had a tent, a lawnmower engine, and a 6-volt car generator. He worked long and



The CW receiver.



The CW transmitter.

Ron and the battery chargers in front of the sound baffle.

hard to get the right combination of pulleys, belts, and generator field resistances so that my 6-volt telephone line batteries could be charged.

Field Days are always cooperative projects, and we needed more manpower. Arnold, WA8OVY, a technician, promised to help us "set up", and offered the use of his 12-volt trailer battery. To charge this battery, I purchased a 12-volt car generator for \$3.00 and mounted it on some boards with another lawnmower engine, some switches, and resistors.

In the search for manpower, I stopped at a house that had antennas and a car with an antenna. There I met Chuck, WA8WAH, and was glad that he was not a "CBer". I liked Chuck and invited him to join the group. Chuck offered to take his Heathkit HW-12A, 75-meter SSB transceiver out of his car for us to use on Field Day. (Being strictly a CW ham, I thought this might be good to make a few contacts when the CW operators got tired. Later, Field Day really educated me to the value of SSB!!!!) Thus, our working group consisted of Chuck, Arnold, David, Ron and me. I was the only one who previously had participated in a Field Day. Although we lacked experience, we had much enthusiasm.

Preparing for Field Day required much thought and work. We carefully studied the rules, and decided that such a small group should not attempt to have more than one transmitter on the air at any one time. By operating Class 1-A, only one transmitting antenna would be needed. We wanted to make each contact count as much as possible. By keeping the CW power 10 watts or less, each contact would count 18 points (independence of power mains 3, times battery power 1.5, times power multiplier 4). For the 75-meter SSB contacts, the power multiplier would be only 2 (50-200 watts), so each SSB contact would count only 6 points. According to the rules, we could get 200 points for using emergency power and 200 points for publicity. *The Detroit Suburban Newspapers* kindly published an article which told of our plans and explained the purpose of Field Day. The article also explained that *our group* would use equipment designed and constructed *especially for portable and emergency operation*, and would not merely run home-station equipment with a portable alternating current generator. Since we had no experienced contest operators, we felt that we would do well to get 100 CW contacts. We thought we could earn 2200 to 2500 points, (1800 for 100 CW contacts, plus 400 "bonus points") plus a few more points from SSB contacts. There was also a possibility of earning 200 more "bonus points" if we could get a message through to the Sections Communications Manager.

To get permission to use a high flat place in River Rouge Park, a letter was written to the Superintendent of the Department of Recreation, phone calls were made, and the park Supervisor was visited. The police were also notified in advance and given a copy of our letter from the Department of Recreation granting us permission to use the park.

Planning and construction work continued whenever time became available. Gooseneck lamps were fitted out with tail-light bulbs and battery clips. Pieces of pipe were collected to be driven into the ground to hold the guy wires. Spare tubes, spare spark plugs, an absorption type wavemeter, and other small items were collected. Lists of things to take were made.

The most important part of any radio sta-

Chuck, Arnold, and the batteries. Chuck's right hand is on the power supply of the HW-12 transceiver.

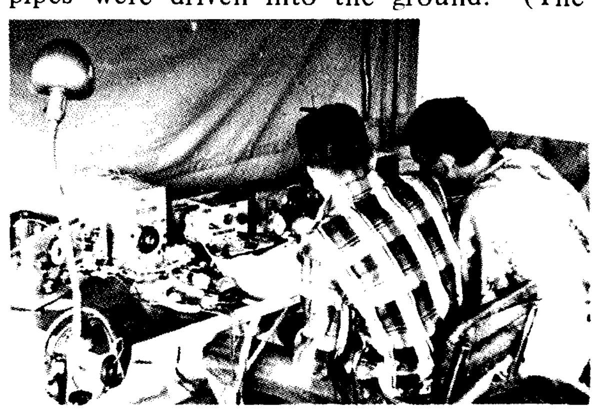
tion is its transmitting antenna. To be effective, a transmitting antenna must have three important characteristics: (1) resonance to the transmitter's frequency; (2) efficient transfer of the radiofrequency electricity from the transmitter to the antenna; and (3) height above ground. The Field Day antenna planned was an "olde tyme centre fed zepp". The two top sections were each to be 66 feet long connected to 64-foot-long open wire tuned feeders in the center of the 132-foot antenna (66 feet either side of the center where the feed line is connected). Thus, on both 40 and 80 meters the feeders could be voltage fed from a parallel tuned (center grounded) antenna tuner, link coupled to the final tank coil of the transmitter. Fifty feet of center height was provided by 2 by 4's, a 12-foot dowel, and fishpoles clamped together. The guy wires were fastened to the top of the 12-foot dowel. The ends of the antenna were about 25 to 30 feet up, one end in a tree, the other end held up by a 16-foot 2 by 4 to which was clamped a small sailboat mast. An open wire feed line was made of No. 14 enameled wire separated by 2½-inch wooden spacers that had been boiled in paraffin. The antenna wire was somewhat thin (No. 20 or so taken from an old loudspeaker field coil), and we twisted nylon string around the wire to support its weight and prevent the antenna from stretching. The antenna and feeders were rolled up on a detergent barrel and stored until Field Day. The four guy wires (broken electrically by "egg" type insulators) were coiled up and stored inside the barrel.

A week before Field Day, a practice session was held in my yard to try out the CW equipment and the six-volt lawnmower-driven generator. (The Heathkit HW-12A and twelve-volt generator lawnmower engine combination were not tried out until Field Day itself.) Ron had a 100-foot-long cable made up of three No. 8 wires which was used to take the dc charging current from the generators to the batteries. This 100-foot distance and a sound-absorbing baffle kept the lawnmower engine noise from being too loud.

During the "dry run", the home antenna was used, and several contacts were made before something "blew" during a QSO with VE3FPM. A .1 mfd 200 condenser in the vibrapack had shorted and was shorting out the telegraph key! The condenser was replaced with a .1 mfd 400-volt condenser, and there was no more trouble. This one correction made the practice session worthwhile. At the practice session a 64-foot piece of wire was cut for the receiving antenna, and a checklist of things to take was made. (In spite of the checklist, when Field Day came, the sledge hammer was left behind!)

There was also mental preparation for the Field Day. In 1966, I purchased a second-hand "bug" (semiautomatic telegraph key) and learned to use it to increase my sending speed. For three weeks before Field Day, I tried to get on the air often operating at as high a speed as possible. (I was probably up to 20 WPM by Field Day.) David, WN8WMV, took code practice every night from W1AW and got his code speed up to 15 WPM. He planned to help with the logging.

The big day came suddenly. In the morning, the equipment, lumber, food, tent, ladder, cot, chairs, table, batteries, antenna, wire, and generators were put near the garage driveway. At about 2:00 pm three loaded cars started for River Rouge Park. At the site, the cars were unloaded, and the long wait (15 minutes) until 1900 GMT began. At 1900 the antenna lumber was put in place, and with a good posthole digger we started digging the four-foot-deep hole into which the eight-foot-long double 2 by 4 center post was put. The long double two by fours were bolted to the bottom of the center post. The center of the antenna was fastened to the top of the fishpole section. The middle sections of the center support were clamped in place. The north end of the antenna was fastened to a rope in the tree. The south end of the antenna was fastened by a rope through the pulley in the top of the sailboat mast, and the antenna was walked up into place. Next, the four guy wire pipes were driven into the ground. (The



Chuck and Ron making contacts on 75 meter ssb. The equipment visible includes the CW station and the antenna tuner.

sledge hammer was badly missed!) The guy wires were fastened to the pipes, and the antenna was "rarin' to go". Next the tent floor was put down near the end of the feed line, so that the antenna feed line could be taken into the tent. As the tent was being put up, the folding picnic table was put up on the tent floor. The station equipment was set up on the table. The batteries were put outside the tent door. (To keep the acid of the batteries from injuring the tent.) The vibrapack was connected up, and we were on the air at 21:23 GMT, before the tent was completely assembled. Later, the generators were connected to the batteries through the 100-foot power cable. Seven 40-meter CW contacts were made before 2200 GMT. Field Day CQs were answered and, to our surprise and delight, most of the stations came back giving us good reports, 569, 579, 589, etc. The ten-watt transmitter with the big antenna was really putting out!

David's code was better than had been expected. His log keeping made it possible for me to concentrate on making contacts. David also made some contacts himself running crystal-controlled in the 40-meter Novice band.

At 2303, Dave and I were tired enough to let Chuck try his 75-meter SSB transceiver. The antenna tuner was connected to the output of the HW-12A, and the transmitter was carefully tuned up. At 2320, the first SSB contact was made, and in 16 minutes nine other contacts were made. What a terrific surprise to this "dyed in the wool" CW operator! Although Chuck had never been on a Field Day before, he operated as if he were an experienced Field Day operator. He instinctively had the knack of getting contacts quickly and with as few words as possible. Ron did the logging for Chuck. At one time, three contacts were made in less than two minutes. With 180 watts P.E.P., the HW-12A and the big antenna were putting out a loud signal. Some stations said the signal was the loudest on the band. (The 12 volt generator and lawnmower engine, that had not been previously tested together, worked beautifully.) SSB worked so well that we wished that we had a way of accurately measuring the input plate power of the final so that we could cut it down to 50 watts, so as to have a larger power multiplier. We think that nearly as many contacts could be obtained with a signal less strong. (We shall take care of this item next year!) The "few extra points" from SSB turned out to be many, many points, 1146 to be exact!

Dave and I stayed up all night working 80-meter CW. Early in the morning, we heard the Sections Communications Manager, W8FX. We were tired, but by "hook or crook", and with much repetition, we managed to get the 200-point message to him.

The rest of the day was spent either with 40-meter CW or 75-meter SSB. We operated until 2155 Sunday afternoon to try to get as many contacts as possible. In all, there were 109 CW contacts counting 18 points each, and 191 SSB contacts counting 6 points each.

(On September 10, 1968, we received a QSL card confirming a Field Day contact from W5US in Texas that would have given us another 18 points. The report said that our signals were 579.)

At the end of the Field Day period, we were sleepy, tired, but very happy. We were thinking about how to improve our score next year! However, even if we were to earn 10,000 points next year, we do not think it really could be a better Field Day than the one we had this year *as beginners*.

This was the Field Day that we shall never forget!

...W8BVU

Sunspots? *Who Needs 'Em for 6 Meter DX*

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Stop! Don't stow that six meter beam in the garage just because someone said the sunspot cycle is declining. The cycle is on the way down but that doesn't mean the end of vhf DX for those who know how.

Many six meter enthusiasts, particularly some who have discovered the pleasures of 50 mhz operation in the past five years, fear that 1968 marked the end of everything but local-area ragchews and net check-ins on ground plane antennas until the sunspots peak again a decade or more in the future. Not so.

Keep that six meter beam high. Peak up your 50 mhz gear. For many of you, the best is yet to come.

If the declining years of sunspot Cycle 20 (the next five or six) are remotely like the waning years of Cycle 19 in the period from late 1958 through 1963, 50 mhz DX possibilities should be plentiful for those prepared to exploit them with knowledge and operating skill. But, you'll need more than a corroded ground plane and poorly-aligned receiver to make the best of them.

Big power? No, that's neither necessary nor desirable.

Working six meter DX consistently is an amateur activity in which, literally, knowledge is power. Six or seven clean watts to a good antenna system does the job nicely. Twenty or 30 watts assure that you can work virtually anything in the world you can hear.

Successful six meter DX operators invest most of their effort and funds in efficient, directional antenna systems and sensitive, reliable receiving equipment. Above all, they learn everything possible about propagation effects that account for 50 mhz DX frequently missed by less informed operators. That's why knowledge *is* power on six. With an understanding of propagation effects, an efficient antenna, and good receiving equipment, you need very little transmitter power to rack up an impressive DX score—with or without sunspots.

Those who have studied the vhf segments of the amateur spectrum carefully in the revealing years since World War II, know that some of the higher frequencies offer excellent DX possibilities in periods when lower frequencies are deep in between-sunspot-peaks doldrums. This is particularly true of the six meter band, a true DX part of the spectrum for those who know how, why, when and where.

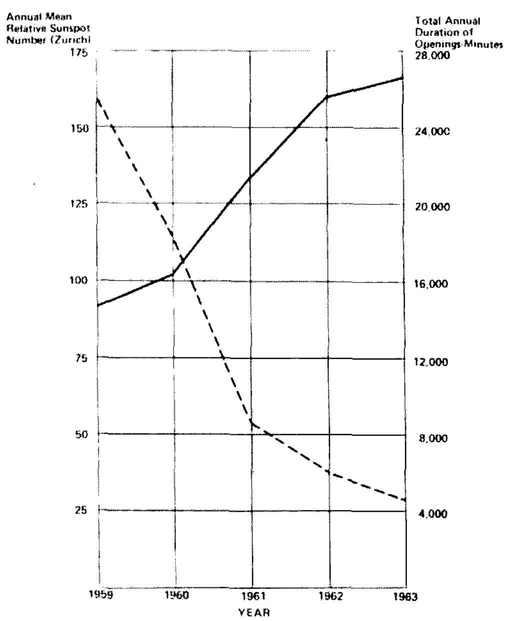


Fig. 1 - Relationship between annual duration of 50 mhz band openings, in minutes, and annual mean relative sunspot numbers as determined by the Swiss Federal Observatory at Zurich. Solid line indicates annual duration of openings (read on scale at right); dashed line indicates annual sunspot numbers (read on scale at left).

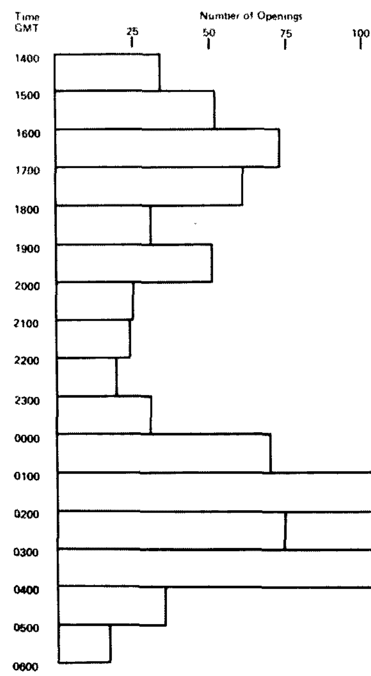


Fig. 2 - Beginning time, to nearest hour, of the 808 six meter openings recorded during the 1958-1964 investigation.

Older vhf operators perhaps recall the five-year investigation of 50 mhz propagation effects that my wife, K7ALF, and I conducted during the declining years of sunspot Cycle 19. That carefully-controlled study was initiated late in 1958, a full year after Cycle 19 had peaked and started down, and continued until January 1, 1964.

The most significant single finding of that 27,855 hour research effort demonstrated that sporadic-E propagation supported six meter DX opportunities *increased steadily as the sunspot cycle declined.* **(Figs. 1, 2; Tables A through H).**

Table A
COMPARATIVE SUMMARY
Six Meter DX
November 1, 1958–January 1, 1964

	1958 2 mos	1959 11 mos	1960 12 mos	1961 12 mos	1962 12 mos	1963 12 mos	Totals or avg.
Avg. mean sunspot number (Zurich)	184.8	159.0	112.3	53.9	37.5	27.9	—
No. monitored days	61	335	366	365	365	365	1,857
No. days band opened	45	99	126	101	113	109	593
No. band openings	70	121	169	140	152	156	808
Total mins. band open	6,197	14,797	16,326	21,316	25,594	26,494	110,694
No. states heard/worked	19	42	30	46	44	40	50
No. foreign prefixes heard/worked	18	11	15	7	10	6	40

Our investigation further showed that the six meter band opened between the Arizona study site (we have since moved to Idaho) and regions *outside* the continental United States in 62.3% of the 61 study months during the constantly declining years of Cycle 19.

But that's just part of the story. DX of one kind or another, foreign and domestic, was recorded in *91.8% of those 61 months,* **(Table D).**

If the waning years of Cycle 20—those from now until 1974 or 1975—are only two-thirds as productive, they will offer six meter DX in more than 60% of all the months during the next five or six years. That's a lot of DX, so keep those beams up and get ready. Sporadic-E (E_s) DX openings should begin mounting this summer.

Some of the things we discovered during the downfall of Cycle 19 can be helpful to you throughout the present sunspot decline. All pertinent data from our 1958-1964 records are contained in the charts and tables herein. This information can help you work more DX with less effort. And remember that at no time during the investigation did we feed more than 27 watts to the antenna. All DX recorded in the first five months of the study was worked with an output of only *seven* watts.

If you aren't familiar with our research, all of which was done on AM, you should know several things not indicated in the statistics. Some of our principal findings were

Table B
STATES HEARD/WORKED
(Figures indicate number of times H/W)

	1958	1959	1960	1961	1962	1963	Total Times H/W
Alabama	0	1	0	4	10	9	24
Alaska	*	4	0	0	0	0	4
Arkansas	3	7	4	7	13	14	48
California	2	24	36	35	32	46	175
Colorado	0	7	12	20	14	18	71
Connecticut	11	0	0	1	3	0	15
Delaware	0	0	0	8	1	0	9
Florida	0	11	3	9	13	17	53
Georgia	0	1	1	3	7	9	21
Hawaii	*	6	1	0	0	0	7
Idaho	0	4	6	7	6	6	29
Illinois	2	2	0	0	3	3	10
Indiana	0	2	0	4	4	1	11
Iowa	0	9	3	10	23	20	65
Kansas	3	9	4	17	28	27	88
Kentucky	0	1	0	4	3	4	12
Louisiana	3	12	13	20	26	20	94
Maine	26	1	0	1	1	0	29
Maryland	0	0	0	4	0	0	4
Massachusetts	25	4	0	7	2	0	38
Michigan	0	1	1	3	2	3	10
Minnesota	0	8	4	12	6	11	41
Mississippi	0	4	0	2	5	5	16
Missouri	3	10	3	20	29	25	90
Montana	0	10	12	9	11	9	51
Nebraska	0	15	21	31	34	35	136
Nevada	0	7	7	8	3	6	31
New Hampshire	15	1	0	2	0	0	18
New Jersey	6	1	0	11	3	2	23
New Mexico	0	0	0	1	5	7	13
New York	7	0	0	6	4	3	20
North Carolina	2	2	1	3	2	6	16
North Dakota	0	7	5	7	3	1	23
Ohio	0	4	1	9	7	10	31
Oklahoma	3	18	15	26	33	31	126
Oregon	0	21	34	25	35	30	145
Pennsylvania	4	2	2	7	8	3	26
Rhode Island	15	0	0	1	3	0	19
South Carolina	0	2	0	2	1	4	9
South Dakota	0	7	8	17	16	16	64
Tennessee	0	4	4	4	9	7	28
Texas	12	42	74	72	85	85	370
Utah	0	3	1	2	3	6	15
Vermont	8	0	0	1	0	1	10
Virginia	1	3	2	8	2	4	20
Washington	0	21	30	22	31	29	133
West Virginia	0	3	1	5	2	2	13
Wisconsin	0	5	2	3	5	8	23
Wyoming	0	8	12	16	10	7	53

*See Table C, foreign prefixes, prior to statehood

in sharp disagreement with widely-accepted theory. That is due, in part, to the fact that much of the DX heard and worked during a sunspot decline is via E_s propagation, a phenomenon about which little was known at that time. Even now, much remains to be learned; that's one of the fascinating things about working 50 mhz DX.

Sporadic-E propagation is the so-called "short skip" form resulting from unexplained, exceedingly high ionization densities occuring sporadically in the E layer of the ionosphere; hence, the term "sporadic-E." Such enhanced densities are capable of reflecting radio waves of much higher frequency than are reflected by the E layer under normal ionospheric conditions. They are therefore extremely helpful to six meter operators who know how to use them.

Unlike the F_2 form of propagation, which on six meters is associated only with high levels of sunspot activity, E_s propagation possibilities on six are in *inverse* ratio to sunspot numbers. As the numbers drop, E_s band openings increase and are of longer duration (Fig. 1). Our 1958-1964 research established this previously suspected, but unverified, phenomenon beyond doubt, at least so far as six meter operating conditions and Cycle 19 are concerned.

Table C
FOREIGN PREFIXES HEARD/WORKED
(Figures indicate number of times H/W)

	1958	1959	1960	1961	1962	1963	Total Times H/W
CE3*	0	0	1	0	0	0	1
CO2	0	0	0	1	5	0	6
CT1*	3	0	0	0	0	0	3
CX8	0	0	1	0	0	0	1
EI2*	4	0	0	0	0	0	4
FG7	0	0	0	0	0	1	1
HC1	0	3	2	0	1	0	6
JA1	1	0	0	0	0	0	1
JA3	1	0	0	0	0	0	1
JA4	1	1	0	0	0	0	2
JA5	3	0	0	0	0	0	3
JA6	1	0	0	0	0	0	1
JA7	1	0	0	0	0	0	1
JA8	2	0	0	0	0	0	2
KH6	8	4	(See Table B after statehood)				12
KL7	10		(See Table B after statehood)				10
KM6*	1	0	0	0	0	0	1
KP4	1	4	0	5	2	2	14
LU1	0	0	3	0	0	0	3
LU2	0	0	2	0	0	0	2
LU3	0	3	6	1	0	0	10
LU4	0	2	7	0	0	0	9
LU5	0	0	3	0	0	0	3
LU7	0	0	1	0	0	0	1
LU8	0	1	0	0	0	0	1
LU9	0	0	2	0	0	0	2
PY6*	0	0	0	0	1	0	1
VE1	33	5	0	0	0	0	38
VE2	4	0	0	0	0	0	4
VE3	1	0	0	1	1	0	3
VE4	0	1	0	1	0	0	2
VE5	0	0	0	0	2	0	2
VE6	0	0	2	5	4	5	16
VE7	0	2	1	0	4	2	9
VK3*	0	0	1	0	0	0	1
VK5*	0	0	1	0	0	0	1
VO2	7	0	0	0	0	0	7
VP7	0	0	0	0	1	4	5
XE1	0	6	8	11	16	4	45
XE2*	1	0	0	0	0	0	1

*Indicates prefix heard but not worked

Don't let that term "short skip" fool you. Six meter E_s openings normally permit working stations from a few hundred to 1,700 miles distant. But at times there is multiple reflection, termed "double hop," which makes many solid contacts possible well in excess of 3,000 miles. Our longest double-hop qso during the last sunspot decline was 3,300 miles. We did it in June 1963 when the mean monthly sunspot number was just 36.6, far below the Cycle 19 peak of late 1957.

E_s openings have two substantial advantages over F_2 openings on six. They are not frequency critical, which means you can work DX just as well at 50.5 or 50.8 mhz as near the bottom of the band where qrm is likely to be heavy, and they last longer; an aid in building up your DX score.

Another form of propagation which is wholly independent of the sunspot cycle is termed "tropospheric" because the phenomenon is associated with the earth's troposphere rather than the ionosphere. There is also much yet to be learned about this form.

As is true of E_s, no single theory adequately explains just how "tropo" works although knowledge of it has mounted in recent years. At present, it is generally believed to be connected with turbulence in the atmosphere.

This connection in turn is thought to be associated with weather fronts. It is suspected that fronts may cause the refractive index of the troposphere to fluctuate at random, thereby aiding six meter operators by bending their signals back to earth at varying distances.

Table D
NO. DAYS PER MONTH
SIX METER BAND OPENED

	1958	1959	1960	1961	1962	1963	Totals
JANUARY	—	13	6	8	3	2	32
FEBRUARY	—	12	4	0	0	8	24
MARCH	—	3	3	3	0	2	11
APRIL	—	—	10	3	5	0	18
MAY	—	4	16	9	23	21	73
JUNE	—	19	21	26	26	27	119
JULY	—	18	21	26	23	23	111
AUGUST	—	14	14	7	2	8	45
SEPTEMBER	—	1	1	2	4	0	8
OCTOBER	—	3	6	6	8	2	25
NOVEMBER	29	7	9	5	4	9	63
DECEMBER	16	5	15	6	15	7	64
Totals:	45	99	126	101	113	109	593

Working tropo on six can be an instructive and rewarding experience. Such openings are marked by two fading components, one rapid, one very slow. These are certain indications of tropo propagation, making it easy to identify.

In addition, there are seasonal variations in median signal levels, with strongest signals in summer months. Also, there are meteorological variations, with best signal levels at times when the troposphere contains very warm or very dry air. All these variations add challenge and DX for those who learn how to exploit tropo.

Still another propagation form unrelated to the sunspot cycle is "atmospheric ducting." This phenomenon is certain to puzzle you the first time you encounter it. Signals from distant stations come booming in. But all of the stations are located within a very compact geographical area, sometimes within one small town or single suburb of a metropolitan area. Operators there can hear you as well as you hear them but neither you nor they can work into other areas.

A duct in the atmosphere often lasts many hours and serves the same general purpose as a waveguide. Signals propagated through ducts are strong and steady but always confined to a small geographical area at each end of the circuit. In effect, a duct serves as an atmospheric radio pipeline between two comparatively small areas on the earth's surface.

Ducts form when the refractive index of the lower atmosphere is altered. This is usually caused by the overlay or shifting of warm and cold air masses in such a manner that a non-homogeneous atmospheric "channel" is formed between or beneath them. VHF radio waves are trapped and superrefracted within the duct which guides them along its length and returns them to earth at the opposite end. The strength and range of signals are enhanced. Often they may be heard 1,500 or more miles away—but only in the area at the other end of the duct.

Add these frequently encountered propagation forms to the less common DX possibilities of scatter propagation and, in northern areas, auroral openings, and you have a helpful collection of six meter propagation tools largely independent of sunspot cycles. Proof that these forms of propagation pay off in good DX is apparent in the results of our investigation during the last sunspot cycle decline.

All of the 50 states and 40 foreign prefixes (Tables B, C) were heard/worked during a five-year period in which the mean annual sunspot number shrank from 184.8 to 27.9.

Table E
NO. BAND OPENINGS PER MONTH

	1958	1959	1960	1961	1962	1963	Totals
JANUARY	—	14	7	11	3	2	37
FEBRUARY	—	15	4	0	0	8	27
MARCH	—	5	3	3	0	2	13
APRIL	—	—	18	5	5	0	28
MAY	—	4	26	9	35	35	109
JUNE	—	23	30	38	41	51	183
JULY	—	20	28	42	33	29	152
AUGUST	—	20	18	7	2	8	55
SEPTEMBER	—	1	1	3	4	0	9
OCTOBER	—	4	8	9	9	2	32
NOVEMBER	52	10	11	5	4	11	93
DECEMBER	18	5	15	8	16	8	70
Totals:	70	121	169	140	152	156	808

Table F
PERCENTAGE OF OPEN TO MONITORED DAYS

	1958	1959	1960	1961	1962	1963
JANUARY	—	41.94	19.36	25.80	9.70	6.45
FEBRUARY	—	42.86	13.79	0	0	28.57
MARCH	—	9.68	9.68	9.68	0	6.45
APRIL	—	—	33.33	10.00	16.66	0
MAY	—	12.90	51.61	29.03	74.19	67.70
JUNE	—	63.33	70.00	86.88	86.67	90.00
JULY	—	58.06	67.74	83.90	74.19	74.19
AUGUST	—	45.16	45.16	22.22	6.45	25.81
SEPTEMBER	—	3.33	3.33	6.66	13.33	0
OCTOBER	—	9.68	19.35	19.35	25.81	6.45
NOVEMBER	96.66	23.33	30.00	16.66	13.33	30.00
DECEMBER	53.33	16.13	48.39	19.35	48.39	22.58

Table G
AVERAGE DURATION OF BAND OPENINGS
(Minutes)

	1958	1959	1960	1961	1962	1963
JANUARY	—	76.0	134.0	68.6	53:3	98.5
FEBRUARY	—	56.3	30.0	0	0	131.0
MARCH	—	51.4	29.0	115.0	0	40.0
APRIL	—	—	59.1	40.0	158.0	0
MAY	—	77.7	101.1	447.2	206.7	159.2
JUNE	—	190.7	95.2	224.5	185.4	212.7
JULY	—	199.9	131.6	130.8	193.2	189.1
AUGUST	—	103.9	53.0	132.1	27.5	170.0
SEPTEMBER	—	132.0	195.0	70.2	38.0	0
OCTOBER	—	38.7	56.8	51.1	49.9	17.5
NOVEMBER	101.2	52.0	55.9	14.0	175.0	78.6
DECEMBER	50.2	212.0	182.0	45.0	129.7	125.0

Table H
COMPARATIVE SUMMER E_S SEASONS
(May 16–August 15)

	1959	1960	1961	1962	1963
No. monitored days	91	91	91	91	91
No. days band opened	51	62	66	63	63
No. band openings	63	89	94	93	99
Total minutes band open	10,157	9,556	18,785	16,870	20,345
Avg. duration of openings (mins.)	161.2	107.4	199.8	181.4	205.5
Avg. no. openings per open day	1.24	1.44	1.42	1.48	1.57
No. states heard/worked	36	28	46	43	39
No. foreign prefixes heard/worked	3	2	6	7	6

The mean monthly number dropped as low as 14.9, yet E_s-supported DX time alone increased steadily for more than five years after the Cycle 19 peak (Tables A, **D**, **G**, **H**). How to cash in on what lies ahead?

First, you should forget some things. Then you must learn some others you may not know at present. And, if you're a newcomer to six meters, don't feel alone. A surprising number of hams with years of experience on the lower frequencies don't know how to work 50 mhz DX consistently either!

Most of the "rules" you've probably heard about working six meter DX mean little during a sunspot decline. Some of these are based on working F_2 openings and you will not find many of those in the next five or six years.

Also, there are some erroneous ideas around that have nothing to do with F_2. For example, you've probably heard or read that E_s propagation may occur at any time but that essentially it is a daylight phenomenon *peaking at or near midday.*

Our investigation showed clearly that there is considerably *more* 50 mhz E_s DX available *in late afternoon and evening hours* and *much less at or near midday* than theory suggests. Of the 808 band openings recorded during our research, more than 50% of the total occurred after 0000 GMT and 41.83% after 0100 GMT (Fig. 2). These are late afternoon and evening hours throughout the United States.

More openings were recorded between 0100 and 0400 GMT than in any other three-hour period of the monitored day. Daily monitoring periods during the study extended from 1400 to 0500 GMT (7 am to 10 pm MST). At times when the band was open or opening at 0500 monitoring was continued until it closed. The gap in our data for the month of April 1959 is due to moving the study site from Phoenix to Tucson, Arizona. The antenna tower and beam were being erected at the new site in April and no records were kept until the entire antenna installation exactly matched that at the former site.

A move like that—only 100 miles— makes little difference in DX results. But bear in mind that your general geographical location determines to some extent how much E_s DX you may expect. There is a relationship between latitude and E_s propagation. This is apparent in the southern states where six meter operators experience an abundance of year-round E_s openings. But those in north-

ern states have the advantage of auroral openings, so things balance out fairly well regardless of where you live.

Here are 15 suggestions for catching more six meter DX than you may believe possible during a sunspot decline. They have worked for me; I'm sure they will for you:

1. A good, directional antenna is a must. Net forward gain of 8 to 10 db *after* transmission line loss deduction is essential. Use the best low-loss coax you can afford and keep your swr down. You need all the gain you can get.

2. Sensitive, well adjusted receiving equipment is much more important than transmitter power. Whether you use a straight 50 mhz receiver or converter makes no difference so long as the result is efficiency and good sensitivity. Transmitter power is secondary and there's little difference between AM and ssb although ssb buffs like to argue the point. CW is not widely used on six.

3. If, like most of us, your operating time is limited, try to concentrate as much of it as possible between the hours of 0100 and 0400 GMT. Next best bet is 1500 to 1700 GMT (Fig. 2).

4. If you haven't already done so, learn to tune, not talk. If you can't hear 'em, you can't work 'em. Local ragchews are fine but don't attempt to mix them with DX chasing. Much fine DX is missed this way.

5. Get a good *modern* book on vhf propagation and read it. Then reread it slowly and apply what you've learned. But keep an open mind; there's much yet to learn that isn't in the books.

6. If you are not doing it now, form the habit of monitoring WWV daily and make notes of the short-term propagation forecasts it broadcasts hourly at five-minute intervals. They don't apply directly to six meters but you will soon learn that disturbed conditions on the lower frequencies can mean DX on six at times. If you don't know how to read the WWV coded forecasts, write to the National Bureau of Standards, Boulder, Colorado, for information; it's free.

7. Be patient. Don't flip on your receiver, tune quickly across the band and, because you hear no DX coming in, assume the band is dead. A lot of DX is missed this way.

8. Look for E_s openings any time but particularly in summer months. They usually peak in June (Table H) and, on a smaller scale, again in December. South American stations are most frequently worked in spring and fall months. Bear in mind that six meter activity has increased substantially in the West Indies in recent years. Look for them when you hear southeastern states.

9. Check weather patterns and beam in directions where rapid weather changes are reported. And learn how to determine when atmospheric inversions are likely to occur in your area. Such knowledge often aids in working a tropo opening before the less-informed competition discovers it and clutters up the band.

10. In busy band openings, choose an operating frequency that takes you out of the heavy qrm. If you stick with the pack you may experience togetherness but it's unlikely that you will get your fair share of DX with low power.

11. When working an atmospheric duct don't waste time attempting to get into areas you can't hear. It's impossible unless some other form of propagation occurs simultaneously.

12. Replace your transmission line every two years. This is particularly important in industrial, desert and coastal areas. Regardless of quality, coax deterioriates in time. A line that does a fine job when new, may rob you of several precious db a few years later. And, check your antenna at least monthly. Wind, snow, ice, smog, birds and salt air do strange things to antennas.

13. Check all tubes in tube-equipped receivers, converters and transmitters every 60 days and retube throughout annually. Sell your replaced tubes to someone who prefers local ragchewing.

14. Never—*never*—get on frequency with a foreign station. Not only is this bad manners, but some foreign operators are so sensitive about it that they will leave the air if some thoughtless U.S. ham commits this cardinal sin. Try 10 or 15 khz away, if you must, but never zero beat foreign DX.

15. Maintain an accurate log and use GMT, which makes life easier for everybody, particularly so when comparing notes with foreign operators. Keep a record of propagation conditions and effects and report your long-term findings to one of the amateur radio journals. There's so much yet to learn about vhf propagation effects that any serious six meter operator who keeps accurate records may well make a significant contribution to scientific knowledge at any time.

Sunspots? Who needs 'em on six meters? There's plenty of solid DX ahead. Good hunting!

...K7ALE

The DX Desk

With this issue, 73 inaugurates this DX page. We do not go to press with any preconceived format; that will depend largely upon you. We will rely upon the comments and suggestions of those who are concerned enough to make the page a reflection of their own needs and wants.

There is no point in including DX items, expedition news, and the like. Our deadline is so far in advance of publication, that by the time you saw such items in print, they would be as cold as a landlord's heart. Moreover, it is not our intention to pre-empt the function of the many news sheets and bulletins in this field. These are readily available and do a splendid job. We urge you to subscribe to one or more of them. They deserve your support.

What, then, will be our function? Just a short while ago, in New York, Wayne and I discussed this. We came to some definite conclusions. We are convinced that there are several areas in which we DX'ers can play an important role. Of prime importance, however, is the job of bringing DX back to its position of former eminence. Many of us, concerned with the state of DX, due to highly regrettable events in the recent past, have lost our taste for the game, and are sour, more or less, on the whole idea. This feeling of indifference and cynicism must be replaced by confidence and a sense of enjoyment. DX is badly in need of a shot in the arm.

I think that what happened to DX was the inevitable result of our own attitudes. We permitted DX to become a dog-eat-dog rat race, and inevitably this resulted in a debacle. The end began to justify the means. Right and wrong ceased to have any meaning. Expediency, rather than ethics, motivated the quest for contacts. We began to overlook the sharp practices, cutting of corners, and outright dishonesties taking place all around us.

This is not to say that the competitive factors ought to be removed. Rivalry is a healthy part of all endeavors. Competition is very much a part of the world in which we live. But when a hobby assumes the characteristics of intrigue, conspiracy, and even blackmail and intimidation, then it is no longer a hobby; it is more like war! When hams resort to favoritism, granting preferential advantage to individuals and groups, the entire hobby suffers irreparable injury.

A spirit of scrupulous integrity and fair play must characterize every phase of Amateur Radio. We can only be considered as worthy and reliable as our most untrustworthy DX colleague. Unfortunately, we are judged collectively, not as individuals.

73's award, WTW, is being administered very carefully. Every entry is scrutinized as through a high-power lens. We do not intend to allow dishonesty to be rewarded, and will tolerate no hanky-panky. We and our validation affiliates are determined to maintain the highest level of integrity in this award. The penalty for cheating is absolute and irrevocable; disqualification without re-instatement.

We've always felt it was too bad that DX contacts are always so brief. A merely cursury exchange of signal reports, names and locations, followed by the usual QRU, vy 73-tks OM hpe CU agn CL dit dit; this seemed always to fall somewhat short. At this point in time, when nations are seeking ways to establish closer ties of friendship and understanding, DX could be a positive force toward building "bridges of peace" among the peoples of the world. It would be good to develop broader contact, deeper relationship on a personal level, whenever possible. Naturally, we do not mean to imply that an individual should tie up a rare DX station in an interminable rag chew when others are waiting to work him. But certainly we could expand our contacts to a certain degree, seeking ways in which to make friends through radio, rather than mere contacts. We actively solicit suggestions from readers, on this point. There must be many of you who have shared more than the tenuous type of momentary contact which, all too often takes place.

Many foreigners talk about "Ugly Americanism." If we can change the opinions of foreign hams with respect to this over-stressed image, we will be doing our country a great service. Never forget that overseas hams also have families and associates, with whom they discuss ham radio, just as we do. Many minds may be changed, many hearts may be reached. People respond to a spirit of respect and courtesy. And these qualities can be displayed effectively during a qso. Perhaps we hams can do a better job in this field than the diplomats and politicians; a sort of person-to-person program.

The very nature of the science of communications attracts many persons to Amateur

Radio. Non-hams are invariably intrigued with the idea of contacting others via wireless. But I have noticed that the more distant the contact, the more irresistable this attracting becomes. Many times, more often than I can recollect, guests in the shack, only mildly interested in stateside contacts, would become absolutely ecstatic at the sound of a VK, ZL or VR coming through the speaker. There seems to be tremendous incredulity attached to the miracle of overseas communication from one's own home. If we wish to improve the flagging growth rate of Amateur Radio, (and it needs improving,) we can contribute much by exposing more people to the intriguing world of DX. I have used one particular ploy quite successfully. First determining the land of origin of the forebears of my visitor, I would then endeavor, usually not unrewarded, to make contact with the country sought. At the first sound of the familiar tongue from the ancestral motherland one can sense the feeling of tension and excitement. I recall vividly one Hungarian fellow upon hearing an HA answer me with the phrase, "Budapest calling you," practically going berserk. He forced me to promise him right on the spot to help him become an amateur as quickly as possible! At this very writing, I am engaged in teaching code and theory to the young husband of one of my wife's friends. He is so set on getting his ticket that he calls me on the phone every day with questions that stump him; too eager to wait for our regularly scheduled get-togethers. And this came about as a direct result of a 4X4 contact.

How about arranging community DX demonstrations with organized groups: Boy Scouts, Lions, Kiwanis, Rotary Clubs, fraternal organizations, etc. These groups are always on the lookout for program ideas for their luncheons and social evenings. If we can set up portable stations for field days and other events, why not for DX demonstrations. A bit of extra effort on the antenna set-up, and it's a cinch! The potential is incalculable. We might win a bonus in the form of a new unwillingness to condemn us for every malfunctioning TV set, while gaining recruits at the same time. We can contribute a good deal toward the enhancement of ham standing in the community, merely by organizing such activity. Of course, someone might say, "What's this got to do with DX?" Well, whoever said that the only hams who can set up these affairs are traffic net people, or Civil Defense people? Why should not DX'ers do the same?

You have probably gathered that I feel strongly that the emphasis, which has always been on individual achievement, should be tempered with the spirit of group effort as well. You are correct in your assumption. DX has never quite reached that plateau of collective co-operation enjoyed by other phases of the hobby. I see no reason for DX enthusiasts to remain isolated from one another in the exercise of their chief interest. The reason that the other types of activity are so well thought of, is because they contribute toward the welfare of society. We must also find ways of doing this. Well, how may this be done? In point of fact, it is being done, and a lot more often than is generally known.

I can cite example after example. When earthquakes strike, and floods and epidemics, American DX'ers are always on top of the emergency, giving of themselves. I know a doctor ham who spent over 48 hours at his rig, running patches during a recent disaster in South America. The same ham has never failed to arrange for overseas shipments of medicines and serums when they were required. Yet, the newspaper coverage in these

situations has been minimal, or non-existent altogether. If a kid jumps into a lake and saves a dog from drowning; if a hook and ladder company rescues a kitten from a tree, there's always a big hue and cry...picture feature stories, and all. But if a ham, through tremendous expense and eagerness to help, saves the lives of entire communities, or gets word through to the survivors of a disaster, you're lucky if you find it opposite the Lost and Found or the used car ads on page 29.

Why shouldn't DX clubs and individual DX'ers get the kind of publicity they deserve. Or is the Little League more important? Or the Garden Club? Or the local standings of the baton twirlers and tiddly wink team? We desperately need publicity so as to improve our public image. And through DX exploits, we can get it. We merely have to get on the ball and establish liaison with the media. How about it? Again, we want suggestions.

*

Now I come to the piece de resistance. I've left it for last, not because it's a delectable tidbit, but because it's a tough nut to crack, and demands serious thought.

The presently designated sub-band segments, and those slated to be added to the restrictions next November, while they may be well intentioned, are working special hardships on DX'ers, most particularly the CW operators. Because these sub-bands were positioned at the very lowest edge of the bands, it is very difficult to prevent the intrusion of commercials and other interlopers. The anticipated use of these segments has not approached the projected estimates. There is very little activity on these low ends, leading to some wide-open spaces which are very attractive to unauthorized operators. There does not appear to be any active move on the part of our League to request a change from FCC. It appears unlikely that any change can take place without the backing of the League. Since the portions in question are, in large part, the concern of DX'ers rather than others, I feel that we should carry the ball in seeking the changes. We can do this only by concerted action, through letters on both an individual and collective basis. We should request that the sub-bands be re-located well up within the central portions of the previously designated bands. I am not asking you to make "waves." I simply feel that an error in judgement has been made, and that an injustice has occurred as a result, and that we ought to try to do something about it by communicating with the League. I hope you will give this your attention.

*

Well, that's about it for this inaugural page. I hope some of it has been provocative. Please get in touch if you think of an idea which has merit. Remember, I told you that the page will reflect your needs and wants. I have no way of knowing what those needs are if you don't express them.

Next time we'll publish the current WTW standings, new certificates issued, and some pertinent data on the award. By the way, some of the fellows are getting so close to the 300 mark, I asked Wayne to have some certificates made up. We surely would like to see more activity on WTW 40 and 80 meters. The other three bands are getting all the action. How about it, people?

...K2AGZ

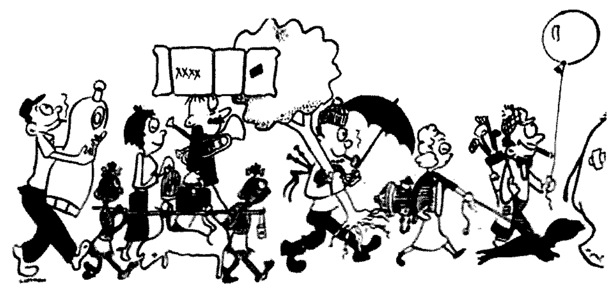
DX Quiz

The Numbers Game

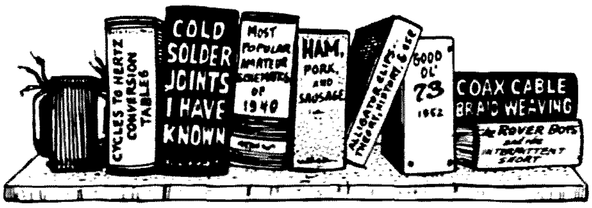
OK, all you DX'ers, let's see how much you remember in the way of country names when faced with prefixes. Score five points for every correct answer. 300-country men should get 100% on this. 250-country ops should get 95%. 200-country beginners should get 90%. Here are the prefixes, you write in the country name. Spelling doesn't count.

1M4	7G1
1S9	7P8
3W8	8F4
4M	9A1
4Z	9F
5B4	9H1
5L2	9K3
5R8	9M2
5T	9X5
5U7	9Y4

The answers to the quiz are on page 117. Don't sneak a look until you've done your very best.



Moving? Please Let Us Know!



NEW BOOKS

Fairchild Catalog

The 1969 *Fairchild Semiconductor Discrete Device Condensed Catalog* is now available. This book contains a complete listing of Fairchild discrete devices, from diodes to FETs to power transistors.

Devices are listed numerically within specific categories enumerated in the table of contents. All are available from your Fairchild Distributors. The catalog contains a list of all the distributors who have these items on the shelf for immediate sale. It contains a numerical index as well as a break-down of the various devices.

Free from Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, Calif. 94041.

New Semiconductor Handbook

Motorola has announced publication of the Semiconductor Power Circuits Handbook, containing the latest information in power circuit design. Prepared especially for users of power transistors, thyristors, rectifiers and zener diodes, this 264-page manual includes many designs being published for the first time. Some 150 new circuits have been specially designed, constructed and evaluated in Motorola's applications test laboratories to ensure design-improving performance.

The information-packed "how-to-do-it" handbook is divided into six chapters that cover the major application areas of interest to semiconductor power device users – (1) motor speed controls, (2) inverters and converters, (3) regulators, (4) static switches, (5) audio and servo amplifiers, and (6) miscellaneous thyristor and transistor switch applications – covering virtually every type of power application.

Approximately 270 illustrations complement the text, providing detail circuit illustrations and waveform diagrams. Complete bibliographies are also included for each chapter.

Copies may be obtained by sending check or money order for $2.00 per copy payable to Motorola Inc., at Box 20924, Phoenix, Arizona 85036.

What Am I Eating?

Can you guess the food from the list of the ingredients? "Contains water, coconut oil, non-fat dry milk, tapioca flour, lactic acid, mono and diglycerides, citric acid, locust bean gum, artificial flavor, quar gum, carrageenan, potasium sorbate and artificial color." What am I eating? See page 136.

Whipping "Two" Mobile

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The need for a better two-meter antenna for mobile use was the reason for trying both five-eighth and three-quarter whip base-loaded antennas. From the schematic, it will be noted that two antennas were tried out, one with a series coil, and the other with a grounded coil with a tap for impedance matching.

The parts required are:

1. Connector, of a type to be determined by individual need. However, in the grounded coil configuration, be sure to use a connector which makes a positive ground connection.
2. Plastic pill vial, size 1-1/8" O.D. and 2-3/4" long, which can be purchased at your local drug store.
3. #14 enamel wire
4. 3/8" dia. brass rod stock, 2" in length
5. 2 ounces of casting resin, catalyst (4 drops per ounce) and coloring if desired. Dye will give a transparent effect, pigment opaque. These items can be obtained from most hobby shops.
6. 1/8" diameter metal rod, 53" long, for series coil antenna.
7. 1/8" diameter metal rod, 48" long, for ground coil antenna (these rods are much longer than necessary).

Construction

Take the 3/8" diameter brass rod. From one end, drill a 1/8" diameter hole 1¼" deep. Measure 3/8" from this end, and at right angles to the previous hole, drill and tap for a 6/32" bolt. Measuring from the same end 1", drill and tap for a second 6/32" bolt. On the opposite end of the brass rod, drill a hole ¼" deep, just large enough for #14 diameter wire.

The series coil is wound on a ¼" diameter form, using #14 wire, 11 turns. The coil length is 1½". At one end of the coil, bend the #14 wire at a right angle, then clip off at 3/8". At the opposite end, bend #14 wire to a right angle, and clip at a distance of 1½". Scrape enamel off both ends. Solder the short end to the brass rod. Take the pill vial, and starting with a small drill, drill a hole in the center of the bottom. Slowly increase this diameter to 3/8", being careful not to crack the plastic.

Insert the brass rod with the coil attached into the open end of the pill vial and slip it through the 3/8" hole so the rod will protrude from the bottom of the vial for a distance of 1-3/8". Slip the coaxial fitting over the long end of the wire, and insert enough of the fittings so that it will be into the vial,

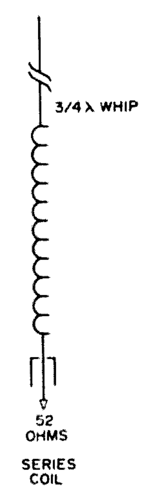

Fig. 1. Coil encapsulated in plastic pill vial.

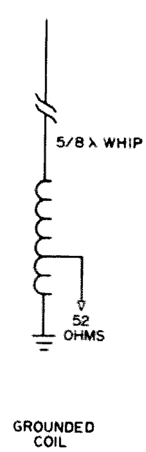

Fig. 2. Three quarter wave whip with series coil.

but be sure the connector will be clear to operate.

Now center the brass rod and keep it parallel with the plastic container and the coaxial fitting. Solder the long wire to the coaxial connector. Check once again to be sure the fitting, the plastic vial and brass rod are all vertically in line.

In order to keep the plastic from escaping, and to keep the brass rod in line, it may be helpful to use either putty or a fast-drying glue. With the vial upright (coaxial connector up) you are now ready to pour the casting resin. This container will require two ounces of casting resin and eight to ten drops of catalyst. If coloring is desired, mix either pigmented color or dye with the resin before adding the catalyst. See the manufacturers instructions for details on mixing. Carefully pour the resin into the vial, and let it stand for twenty-four hours.

The second antenna is made in very much the same manner, except the coil is wound on a 5/8" form. The total number of turns is six, and the spacing between turns is the width of the wire. The end opposite the brass rod is soldered to the outside material of the coaxial fitting. A piece of flexible #16 wire is brought up through the connector and is tapped to the coil two turns from the grounded end.

To prune these antennas to frequency, use a piece of expendable wire the same diameter as the final whip. Insert into the opening of the brass rod and secure with 6/32" bolts. Insert a standing wave bridge in the coaxial line, tune up the transmitter, and check the swr, which should be fairly high. Shut off transmitter and clip approximately ¼" from the top end of the antenna. Turn on transmitter, retune, and check swr. Keep using this procedure until swr is at minimum. After finding the proper length, remove the whip and use this measurement for the permanent antenna, which will be made of spring metal. For best results, be sure this pruning procedure is done at the permanent position of the antenna on the vehicle.

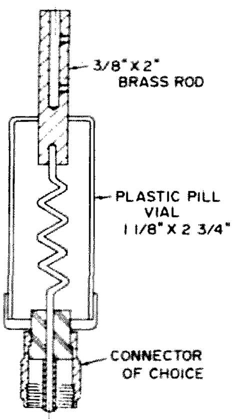

Fig. 3. Five eighths wave whip with grounded coil.

The tests were conducted over as flat a terrain as possible, trying to preclude the possibility of reflections. Three different test sites were used. The reference antenna was a quarter-wave 19" whip. All tests conducted showed the long antennas to give better signal strength and less mobile flutter both on transmit and receive.

It would appear that possibly the three-quarter wave antenna has a higher angle of radiation than the five-eighths wave antenna; however, not a sufficient number of tests were made for angle of radiation to be conclusive. It would also appear that there was no advantage in one method of coupling over another. The number of tests made was thirty. Although S-meter readings in most receivers are rather meaningless, they do give us a relative indication as to strength. The thirty tests made showed an average increase of over one S-unit. The standing wave ratio of the various antennas was as follows:

Quarter-wave, 1.3 to 1
Five-eighths wave, 1.1 to 1
Three-quarter wave length, 1.2 to 1

The antenna was located on the roof of a station wagon. The transceiver was an SR-42, and the standing wave bridges were a Mars and a Calrad.

Although it is never a good idea to encapsulate the antenna coil, in this case the inductance was so small that no apparent differences were noted between this type of construction and air-wound coils. It was apparent the mechanical advantages were well worth any slight degrading.

...K6ZFV

Design of UHF Tuners Using Silicon Transistors

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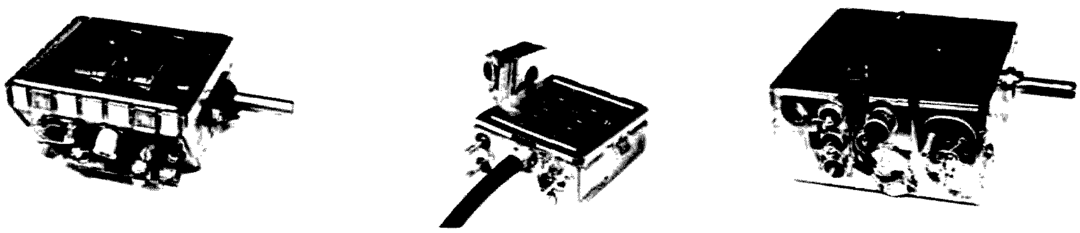


FIG. 1. PHOTOGRAPH OF THREE UHF TV TUNERS IN THE MARKET.

Since the 1964 FCC requirement that all television sets provide UHF reception, manufacturers have spent considerable time and money on the design and development of economical UHF tuners.

Size, performance, cost and reliability are the objectives in tuner design. The introduction of small screen portable sets has made the dimensions of the tuner a decisive factor in design. A miniature UHF tuner is attractive in that it may be used in all sets, but miniature units are not efficient in performance and are expensive to manufacture. A larger tuner, for example, 2.7" x 1.3" x 2.8" is more efficient, easy to manufacture, but often will not fit in small sets. The size problem is solved by manufacturing different size tuners, but this requires additional manufacturing lines and increases inventory cost.

Transistorized UHF TV tuners are superior to tube types because they can be manufactured in small sizes, are more efficient and stable, and do not require periodic maintenance while providing a longer life span. Figs. 1a, b and c show three sizes of UHF tuners presently in use. The first two can be used in small screen portable sets while the larger is suitable for console sets.

Description

The UHF TV tuner described here was built to demonstrate the capability of the new UHF oscillator device, SE3005, and to provide guide lines for its use in tuner design. After the basic size of the tuner is established the design problem would be to assure optimum performance, simple construction, reliability, low cost and ease of manufacturing. Fig. 2 shows the finished tuner. The two compartments on the left are double tuned passive *rf* pre-selector cavities, while the third, on the right, is the local oscillator cavity. The center section also houses the mixer diode and associated components.

RF Sections

The pre-selector *rf* cavities have capacitively tuned lines. The lines and the cavities are self resonant at 1,000 MHz. The lines are selected by an empirical method, mathematical analysis is difficult because the frequency of operation spans from the point where simple transmission line theory can

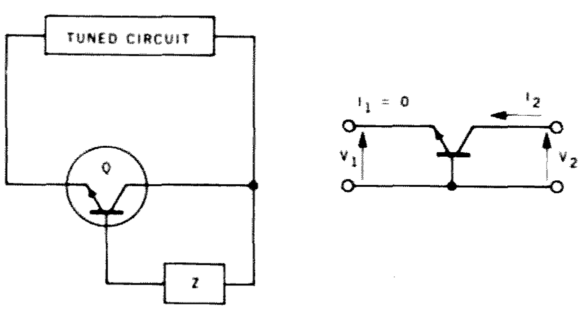


FIG. 1A. BASIC TRANSISTOR OSCILLATOR CIRCUIT.

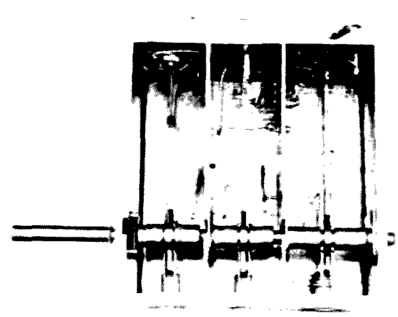


FIG. 2. PHOTOGRAPH OF TOP VIEW OF A UHF TUNER.

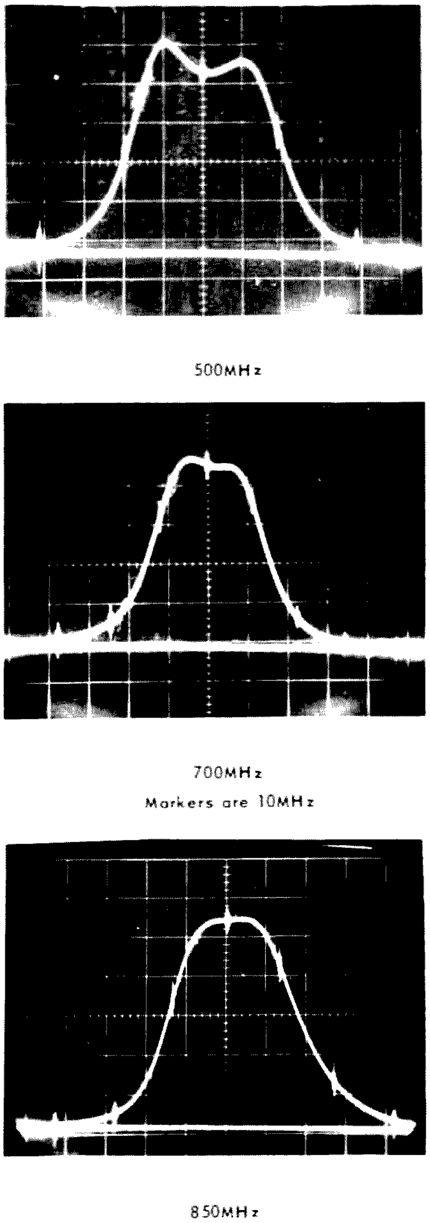


Fig. 3. Q_L of the tuner at three different frequencies.

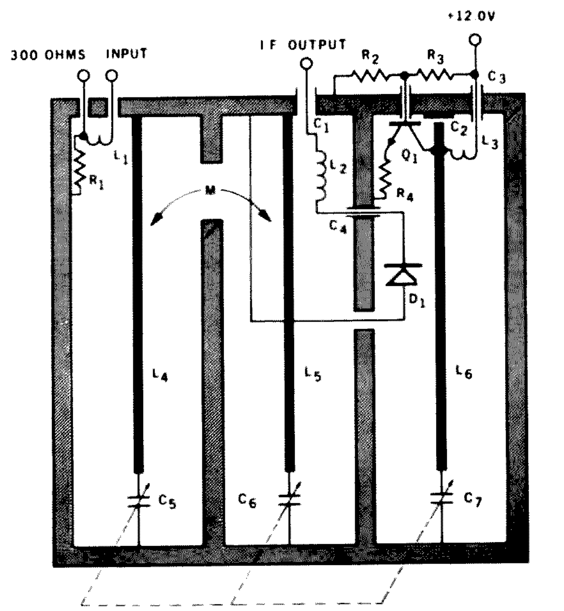
be applied (890 MHz) to frequencies where lumped inductance (470 MHz) is effective. The loaded Q_l of the cavities are high at the high frequencies and lower at the low frequencies. The calculated unloaded Q_U of the cavities is about 1,500 at 470 MHz and 1,800 at 900 MHz. The Q is considerably lower at 470 MHz because the variable capacitor's sliding contacts acts as a signal path at this frequency. The bandpass response of the pre-selector cavities is shown in **Fig. 3** at the indicated frequencies. These cavities are coupled by a 1.3 x 1.8 cm window. The location and the dimensions of the window are determined by the bandwidth requirement and the location of the capacitor rotor shaft.

The 300-ohm input is inductively coupled to the cavities. The lines in *rf* sections are 2.4" x 0.4" x 0.05" silver plated brass. One end of each line is welded to the cavity wall, while the other is anchored with a ceramic stand-off. This method of mounting helps to prevent microphonics.

Oscillator Section

A common-base oscillator was used. The SE3005 has sufficient internal feedback capacity to sustain oscillation across the UHF TV band. Therefore, additional external feedback was not used. The schematic of the oscillator circuit is shown in **Fig. 4**. The transistor base was *rf* grounded through capacitor C_1. The collector tuning tank circuit consists of the transistor collector capacitance, line L_6, and variable air capacitance C_7. The transistor collector was shunted with capacitor C_2 for the desired frequency of oscillation and stability. Capacitor C_2 is a ceramic disc; one side of it was soldered to the cavity wall and line L_6 was soldered to the other side. Therefore, C_2 acts as support to one end of L_6 while the other end of L_6 was supported by a ceramic column. Tying down L_6 in this manner prevented the possibility of mechanical vibration.

The oscillator was biased for minimum



R_1 = 15M	C_4 = 50 pF. Tubular
R_2 = 3.3k	L_1 = Matching network for 300 Ohms
R_3 = 10k	L_2 = 5T, 0.15" ID. #24 Wire
R_4 = 330 Ohms	L_3 = 10T, 0.10" ID. #24 Wire
C_1 = 500 pF. Tubular	L_4, L_5, L_6 = See text
C_2 = 10 pF. NPO	Q_1 = SE3005 Fairchild
C_3 = 1000 pF. Tubular	D_1 = FH1100 Fairchild

FIG. 4. A TYPICAL UHF TV TUNER SCHEMATIC.

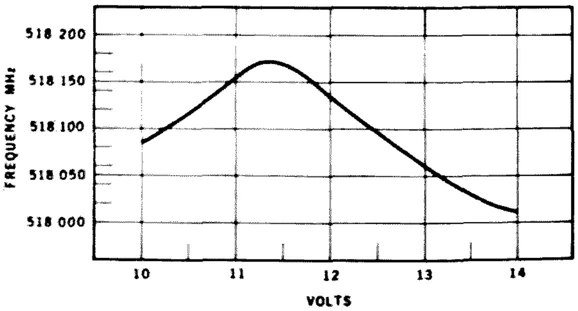


FIG. 5. FREQUENCY VARIATIONS WITH VOLTAGE.

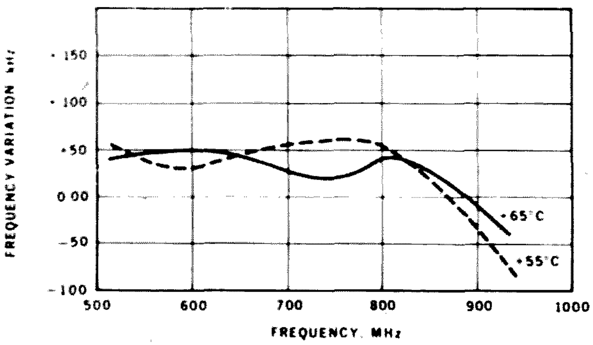


FIG. 6. FREQUENCY VARIATION WITH TEMPERATURE.

frequency drift. Fig. 5 shows frequency drift versus bias voltage while Fig. 6 shows the frequency stability with temperature change.

The oscillator cavity was built larger than the *rf* cavities for ease of soldering the transistor and its associated bias components. The transistor leads were kept as short as possible because long leads have an adverse effect on oscillator performance.

Mixer Section

The mixer section consists of a Hot Carrier Diode (FH1100), an inductance (L_2), a capacitor (C_4) and two pick-up loops. One loop is used in the local oscillator cavity and the other in the mixer cavity. The mixer cavity works as follows: The incoming *rf* and LO signals are coupled into the non-linear diode element; the LO signal forces the non-linear diode element to become a time-varying active network. Under this

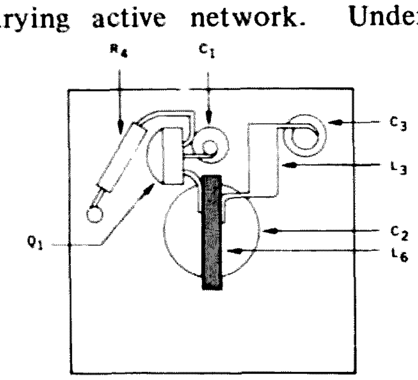


FIG. 7. COMPONENTS LAYOUT FOR OSCILLATOR.

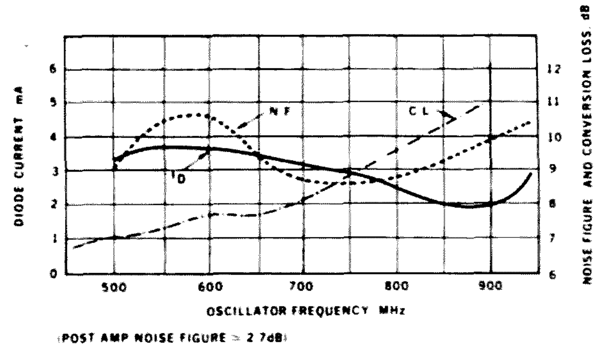


Fig. 8. Diode current, noise figure, and conversion loss of tuner.*

condition the diode generates harmonics; either the sum or the difference of LO and *rf* signals is extracted from the output of the mixer diode and is called the *if* signal. In UHF TV tuners, the LO signal frequency is above the *rf* signal. Until 1966 point contact diodes were used as mixer diodes in UHF TV tuners but Hot Carrier Diodes are seeing increased usage because of better reliability, better V-I characteristics, low noise figure amd low conversion loss.

The inductance L_2 and capacitance C_4 provide a low-pass filter for the *if* signal and provide a matching network between the diode output and the *if* amplifier. L_2 and C_4 are self resonant at 80 MHz for image suppression. The mixer diode current is adjusted by changing the size of the pick-up loop in the oscillator cavity. The magnitude of the diode current depends on loop area and its proximity to the line L_6. The location of the loop was chosen to prevent overloading the oscillator. Since the location of the loop would change the load reflected to the transistor, it could cause the oscillator to stop. Fig. 8 shows the diode current, noise figure and conversion loss variations across the UHF TV band for one diode loop setting. A smooth current output is desired since excessive variations impair overall reception. Forward biasing the mixer diode will affect the noise figure and output current; however, an optimum bias setting is difficult to establish because the oscillator output is not constant across the UHF band.

Conclusion

The tuner described here performs with an output that was not appreciably affected by variations in transistor parameters. Since mass production was not the aim, life expectancy or durability of the cavity under use was not analyzed.

Adjusting FM Deviation

The proper adjustment of the deviation control is important for good FM communications. If it is too low, the audio at the receiver is also low. If it is too high the over-deviation will bring you reports that though your signal is strong, it breaks up when you talk.

Test instruments for measuring transmitter deviation cost upwards of $250. There is, fortunately, a shortcut method for deviation measurement using just an FM receiver and an ac voltmeter (or oscilloscope).

To adjust deviation using this method you must use a receiver with the appropriate bandwidth. The economy priced monitor receivers are of no use here. If you want to use a narrow band ± 5 khz system, you must use a receiver with this bandwidth. If your system contains both wide and narrow band units, adjust all transmitters for narrow band operation. This will cause slightly reduced audio in the wide band receivers, but will provide much better overall performance.

Most commercial units such as Motorola, GE, etc., have power supplies which will allow the transmitter and receiver to be used simultaneously for short periods of time. Refer to the schematic to see how this can be accomplished. In this way you can use your receiver to check the deviation of your associated transmitter.

Connect the ac voltmeter or scope across the speaker terminals. Substitute a five watt resistor for the speaker if you can't stand the noise. Apply a 1 kHz tone to the transmitter or whistle steadily into the mike if an audio oscillator is not available. Slowly advance the deviation control from its lowest position (with the transmitter turned on) and watch the ac meter.

As you increase the deviation you'll see a fairly linear increase in the receiver audio level, followed by a flattening out, and then, as you go outside the passband of the receiver, the audio level will fall off and the noise level will increase. This is just what happens when an over-deviated signal is received by another FM mobile.

Repeat the adjustment several times, paying particular attention to the point at which the linear rise just starts to flatten. This is the point at which the deviation control is properly set.

I've used this system to set deviation on many occasions and have been amazed at its accuracy when compared against properly calibrated instruments.

Review of Heathkit IT-28 Capacitor Checker

Eugene Fleming, WØHMK
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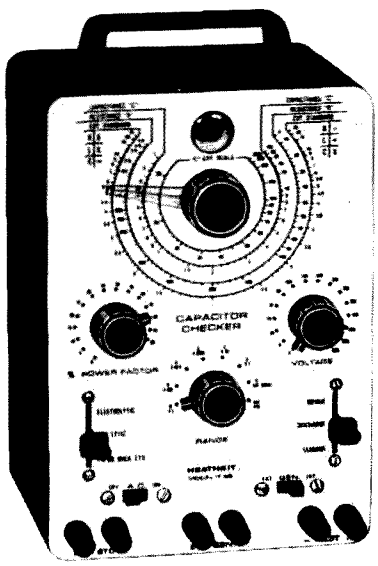
Grand Junction, Colorado 81501



A careful scanning of most of the electronics magazines from the early '50s to the present has brought to light some interesting capacitor checker circuits, but none of the construction articles on these instruments boasted a range from picofarads to hundreds of microfarads.[1,2] This is the range encountered by even a casual builder.

Examination of the specs. of commercially available capacitor checkers revealed that most of them do not cover the wide range of values needed by the experimenter and builder. The one that is satisfactory has a price tag that disqualifies it.

When the announcement of the revised Heathkit Capacitor Checker IT-28 recently appeared, I immediately began to devise means to get the XYL out of the house long enough for me to pick the lock on the piggy bank.

Manual

An outstanding feature of the kit is the three page circuit description included in the construction manual. Simplified schematics are used to clarify the theory of operation. Any ham with elementary knowledge of test instrument circuits will find these pages enlightening reading even if he has no intention of building the tester.

In addition to the standard Heathkit step by step instruction and pictorials, there is an easy to read two page schematic of the instrument at the back of the manual. Included on the schematic are operating voltages expected at the tube sockets, which are indispensable for trouble shooting.

Circuit

The big surprise came when the power supply schematic was examined. The half wave vacuum tube rectifier is unusual for new equipment in this time of semiconductors. A little reflection indicates that there is about 1500 PIV in the circuit, which inexpensive diodes do not handle.

The heart of the IT-28 is the bridge circuit, which uses the 6E5 "eye tube" as an amplifier and null indicator. Three resistance and three capacitance standards are included in the instrument. Driving voltage for the bridge is provided by a transformer which supplies 60 Hz ac. Provision is made for use of external driving voltage of up to 10 kHz. There is also provision for connection of standard resistance, capacitance, or inductance for comparison with a component of unknown value connected to the "Test" posts.

Construction

Construction time for a nearsighted, butterfingered technician was approximately 9 hours.

Wiring is greatly simplified by a ready-made harness that already has the insulation stripped from the ends of the wires. Components are uncrowded for the most part.

Most of the electronic components are mounted on a conventional chassis using

tube sockets and terminal strips. Controls are bolted to the front panel. A sizable portion of the construction time is consumed in the interconnection of the panel and chassis.

The hardest part of the whole operation is mounting the line cord strain relief insulator.

Even the beginner should have little difficulty getting this instrument to operate, for construction is straightforward.

Operation

With 8 front panel controls, this instrument might at first glance appear a complicated knob twirler's delight. It does not turn out to be nearly as complicated as it looks. Care is required to be sure the range, bridge-leakage, type, and power factor controls are properly set before beginning to try to get the eye tube to open.

Anyone with vtvm available will find resistance measurement easier with it than use of resistance ranges on the IT-28, even though these ranges are quite usable. The 200 ohm, 1% resistor included for calibration of the instrument also comes in handy for calibrating the vtvm.

The capacitance ranges are a real delight to those who salvage parts from defunct equipment, but who do not want the "junk box" cluttered with components in doubtful condition. These ranges will serve the builder or repairman well as a tool in positively indicating a capacitor's condition.

For best results in checking capacitors of a few tens of pf, it is best to use an external generator connected to the posts supplied for the purpose. A check indicated the frequency of the external signal is not as important as the ability of the generator to supply adequate voltage to the low impedance of the input. A 1000 Hz tone taken from the 16 ohm output of an amplifier running at high gain made the null much sharper than did the internal 60 Hz. It was possible to measure capacitance of a pair of twisted wires.

The "Mini-lytic" function of the "Type" switch will be most useful to those who work with transistor circuits. Who doesn't, these days?

The "Electrolytic" function also provides a test of "power factor" of the capacitor. "Power factor" is the cosine of the angle by which the applied current leads the voltage in a capacitor. Use of a capacitor with a high power factor can seriously degrade the performance of filter, bypass, or coupling circuits.[3]

The "Leakage" position of the "Bridge-Leakage" switch will test quickly the condition of all three types of capacitors, with differences in type taken care of by proper setting of the "Type" switch.

Since the instructions specify that the upper operating frequency of the IT-28 is 10 kHz, it is inconceivable that the comparator range is useful for checking any inductance other than those used at audio frequencies. If much work using this range is anticipated, precision inductances of 1 henry and 100 milahenries should be acquired. Turns ratios of those old transformers cluttering up the "junk box" can also be determined.

Conclusion

For the ham builder who has a vom or vtvm, a grid dip meter and access (maybe at the corner drug) to a tube checker, the IT-28 is recommended highly as the next piece of test equipment.

...WØHMK

References:

1 R.L. Waters. "Direct Reading Capacitance Meter," *Radio-Electronics;* Vol. XXXIV, No. 8 (Aug., 1963), pp. 32-33.

2 Eugene Fleming, "Electrolytic Saver," 73; Nov., 1964, pp. 31-32.

3 H.P. Manly, "Power Factor...What It Means," *Radio-Electronics;* Vol. XXVIII, No. 7, p. 82 ff. (Aug., 1963).

Specifications:

Test Circuit

AC bridge powered from internal 60 hz or external source.

Ranges:

Capacitance–10 picofarad to 1000 microfarad in 4 overlapping ranges, one range for comparison with external standard.

Resistance–5 ohms to 50 megohms in 3 ranges. One range for comparison with external standard.

Inductance–One range for comparison with external standard only.

Power requirements

115 or 230 (nominal) volts ac 50/60 hz. 30 watts.

Internal power supply

Half-wave rectifier.

Tube complement

6E5, 6AX4, 6BN8.

Controls

Bridge balance, power factor, test voltage, range switch, type switch, bridge-discharge-leakage switch, on-off, int.-ext. bridge power.

Size

9-5/8"x6-5/8"x5"

Weight

5 pounds.

How to Convert Your Receiver for 6 Meter Reception Without Really Trying

...a chapter in the life of a 75A2...a story that asks the question, "Will Collins recognize this receiver after he's done with it?"

Robert L. Grenell, ex W8RHR
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Cincinnati, Ohio 45227

Those of you who are fortunate enough to have a 75A2 have undoubtedly been waiting with bated breath for someone to write an article on a six meter conversion. This is your lucky day, because you can now resume normal breathing. You can also prepare to dig into the innards of your receiver.

One feature I particularly wanted to incorporate in my revision of the 75A-2 was the convenience of internal capability for 6-meter coverage. The 75A-2, being a double conversion receiver with a crystal-controlled first oscillator, lends itself to this treatment very nicely, since the front end is really a multi-band crystal-controlled converter. I even had an extra bandswitch position to play with, since it originally covered the lamented 11 meter-band, tuning 26 to 28 MHz. In order to keep the bands in ascending order, I decided to convert the 11-meter band to 10, and 10 meters to 6. The first step entailed only plugging the 10-meter crystal into the 11-meter socket and repeaking the coils. Nothing much to that.

Now, the fun began. First, there were a number of decisions to make and considerations to be met. The *rf* stage uses a 6AK5. Let's face it-6DC6's, 6BZ6's and 6GM6's notwithstanding, you can't find a better tube than the 6AK5 for low noise, high gain, and efficient performance over a wide frequency range. Futhermore, we're talking about 6-meters, where atmospheric and thermal noise are the limiting factor. Only in cases of the grossest misdesign or bad tube choice will the front end noise ever be a serious problem. The 6AK5 is still in excellent shape at 50 MHz. So, I decided to leave the *rf* stage alone-except for the coils. The 6AK5 is just out of vogue, but it's far from outmoded. Obviously, the noisy 6BE6 mixer would have to go, but first I wanted to get things perking on 6 so I could try some substitution tests. I was not particularly impressed with the

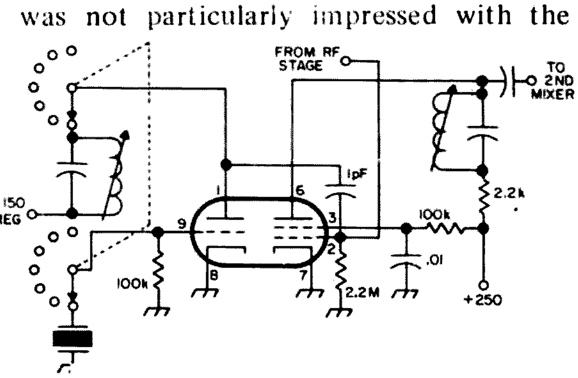

Fig. 1. Mixer-oscillator conversion suitable for adding 6 meter coverage as installed in the Author's 75A2. It is also recommended for improving the performance of older receivers. It features low noise and excellent performance over a wide frequency range. The 6EA8 offers a conversion of 4000 microhmos.

range of tubes which I could try in this application, but, as you will see, circumstances forced me to an excellent choice.

I now began to physically attack the receiver. The 10-meter coils were pulled, rewound for 6, reinstalled, and peaked with a grid-dipper. I plugged in a 55.455 MHz overtone crystal. Nothing happened. It wouldn't oscillate. It seems that the Collins 12AT7 multivibrator oscillator circuit required more crystal drive than I could get at that frequency. Major surgery was called for. Now I had to redesign the oscillator as well as the mixer. However, the problem of choosing a mixer was solved. A quick survey of the tube manuals, literature on new equipment, and back issues of 73 revealed that my best choice would be the 6EA8, a triode-pentode mixer-oscillator closely related to the 6U8. This nifty little bottle is designed for VHF television applications, and provides a conversion transconductance of 4000 micromhos compared to only 475 for the 6BE6—which is a noise generator above 20 MHz. It has excellent noise characteristics, and I felt sure that 6-meter performance would be good, and 10-meter performance much improved.

Everything was stripped from the 12AT7 and 6BE6 sockets. The mixer-oscillator circuit shown in Fig. 1 was built up using the 9-pin socket. The only other change necessary was to reduce the value of the VR tube dropping resistor from 2500 to 2000 ohms. I plugged in the 6EA8 and peaked up the oscillator coil. It took off at once. I realigned the whole front end and started listening. Results were beautiful. Without the masking noise of the 6BE6 I discovered how noisy my location is! The extra gain and low noise characteristics of the 6EA8 really shine on 10 and 15. Signals average 6 to 8 db farther out of the noise than before the conversion. On the lower bands, there's little difference, predictably, except during opening and closing on 20, when the low noise factor and extra gain help greatly. Performance on 6 is excellent. The noise figure is slightly better than that of the familiar Handbook converter using 3 6CW4's! If that seems hard to believe, remember that a converter running into a receiver is subject to matching problems, and that every stage means that more noise is generated in the receiving system. The use of converters as we are accustomed to them is convenient and economical...but it's certainly not optimum!

Six-meter ground-wave reception is solid for a 100 mile radius, and I regularly hear stations in Michigan, Tennessee, Pennsylvania, and West Virginia—as well as the expected Kentucky and Indiana. Although I don't have the equipment necessary to make a good evaluation, receiver noise is well below thermal and atmospheric noise. I hear everything anyone else in the area hears, and more than some. Birdies are not evident, another advantage of an internal arrangement over a converter set-up. The conversion was completed by making the appropriate changes in MHz dial calibration and the band switch index. A conversion of this type is easy and suitable for any receiver having a crystal controlled front end. Even if you don't have an extra band (like 11 meters) to play with, you can add a position on your bandswitch, if you're the ambitious type.

The whole thing goes together easily, is uncritical, and stable. It's nice to be able to flick up to 6 without having to wade through the usual rat's nest of wires, and there's absolutely no compromise between convenience and performance—both are improved! The only thing I don't like is that empty socket that used to hold the 6BE6 mixer. It just sits there begging to be used. Let's see now... what could we put in there...?

...W8RHR

Monitor 2

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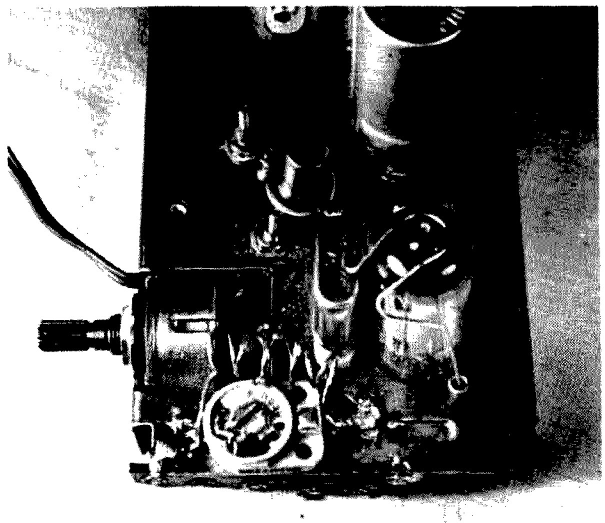
The need for Monitor 2 arose from the many hams who want to monitor two meter repeaters while still leaving their main equipment free, and possibly is an answer to 24-hour-a-day emergency listening. It was decided to make the project as easy as possible, with high reliability and low cost.

The basic receiver is the old standby, the five-tube ac/dc broadcast radio (12BE6, 12BA6, 12AV6, 50C5 and 35W4), purchased from most catalog houses or drug stores for about $10. Most of these imports are hand wired, and this is recommended for ease of conversion.

The major change is at the converter (12BE6). The *if*, second detector, and audio stages are left as is. Remove the variable capacitor, antenna coil and oscillator coil. This will give you the space needed for the crystal oscillator tube and components. The oscillator is the one described by Frank Jones, W6AJF ("The Overtone Harmonic Crystal Oscillator," *CQ Magazine*, February, 1963). This is an excellent circuit, and makes possible this simple conversion.

Remove everything from pins 1, 2, 6 and 7 from the 12BE6. Bypass filament pins 3 and 4 to ground with a .002 capacitor. Mount L-2, C-2 as close to socket as possible. One side of L-2, C-2 connects to pin 7. The other ends of L-2, C-2 connect to ground. Connect a 27 K ¼ watt resistor and a 4.7 pf capacitor from pin 1 to ground. Dress this resistor close to the chassis. This completes the mixer conversion.

The oscillator uses a 6CW4. Although the filament current is slightly different from the rest of the tubes, no harmful effects have been noted. Trace the filament series string and find that filament lead which goes to ground. This will vary according to the manufacturer. Remove from ground, and install a choke made up of ten turns of hookup wire 1/16" in diameter. From the previous filament, connect to pin #12 of Nuvistor socket. Also bypass to ground with a .002 capacitor. Ground pin #10. This completes the filaments. From pin #8, connect a 4uh choke and a 10 pf capacitor. Ground the opposite ends. From pin #4, install a



The Monitor 2.

100K ¼-watt resistor, also a lead to crystal socket. The opposite end of resistor and crystal socket go to ground. From pin #2 connect a lead to top of L3 and C3. Also connect lead of 4.7 pf capacitor. The opposite end goes to pin #1 of 6BE6. At the bottom of coil L3 and C3, bypass to ground with a .002. Also connect a 4700 ohm resistor. The opposite end of resistor goes to nearest B-plus lead. This completes the oscillator circuit.

For those who live within line of sight of the repeater, this simple mixer-oscillator should provide enough sensitivity. For an antenna, connect a piece of insulated wire from the top of L-2, C-2 to back of receiver, then to a wire rod. Because the receiver is hot to ground, be sure to use insulated sleeving over antenna. The connecting wire and rod should measure 38" overall. It is interesting to note that this directly coupled antenna outperformed any attempt to use an outside ground plane.

For those not in line of sight of the repeater, the following *rf* amplifier is very worth while. The *rf* amplifier is quite straightforward. Just be sure antenna coil is shielded from the mixer coil or at least at right angles. The transistor was taken from the *rf* section of a junked RCA FM receiver. Most PNP vhf transistors should work quite

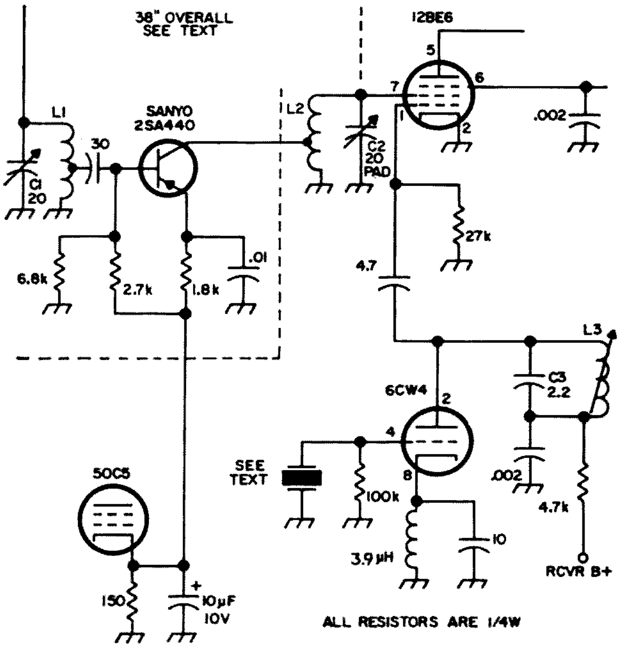


Fig. 1. Complete diagram for Monitor 2.

L1—5T, ¼" diameter, 3/4" long, airwound center tap.
L2—3T, ¼" diameter, 3/4" long, airwound center tap.
L3—4T, ¼" diameter, ¼" long, Miller #4300.
L4—3.9 uh choke.

well, and perhaps a FET would be better. The power for the *rf* amplifier is taken from pin #1 (cathode) of the 50C5. Be sure to use a cathode bypass capacitor if it is not already present. Ten to twenty-five mf, ten volt.

The crystal is a third overtone, and is lower in frequency than the receive signal. The reason for this is that the receive signal that I wanted to monitor was at 145.100 mhz. Due to the fact the *if* frequency is 455 hkz, this puts the image on the lower end of the two-meter band. In one month of monitoring, no image signal has been heard; however, if the receiver is to be used in the upper end of the band, perhaps the crystal frequency would be better on the high side. This will depend on the activity in your area.

As to the crystal frequency, after it has been multiplied three times, it must be 455 khz different than the receive signal or thereabouts. If a surplus crystal is found near enough in frequency, the *if* transformers can be shifted to allow for some difference, for 455 khz is the design center of the *if* transformer, and it can be moved up or down in frequency. For example, in the author's receiver, the crystal used (surplus) is marked "48.222 MC." After being multiplied, it gives a frequency of 144.666 mhz. The frequency of the monitored repeater is 145.100 mhz; therefore, the *if* frequency is 433 khz. The *if* transformer has been shifted 22 khz.

Tuneup

First adjust L-3 in or out until oscillator oscillates. This can be determined by your regular receiver tuned to the multiplied oscillator frequency. Then check for repeater activity. If on, tune first *if* until repeater is heard, then peak for maximum, then the same for second *if* transformer, then peak C-2 for maximum and C-1 for maximum (if used).

Conclusion

This receiver has given excellent reliability, has a narrow bandpass, no drift problems, small in size (5" x 8" x 4"), light weight and low power consumption. By their basic design, any ac/dc radio is dangerous when out of its case. Be sure to remove power cord before working on chassis. In tuning, use insulated tools, stand or sit on insulated material.

Any of the conventional noise clippers or squelch circuits may be used if desired.

...K6ZFV

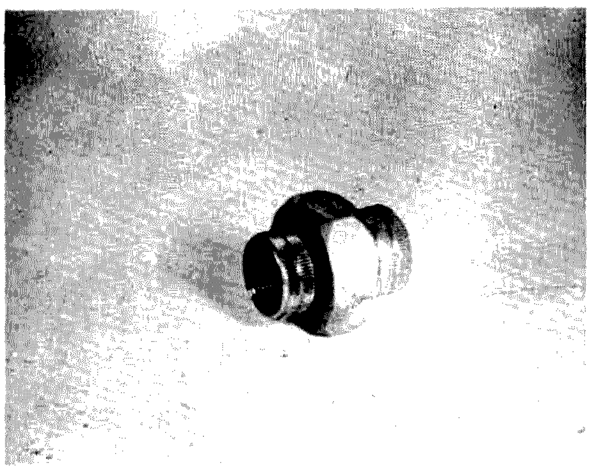
40, 20, and 2

Thomas Niedermier, WA8IYL
Box 163
New Washington, Ohio 44854

The tower here that supports the two meter ground plane and twenty meter inverted dipole also serves as a forty meter vertical. It consists of thirty three and one half feet of one and one quarter inch pipe insulated at the top and bottom with a dielectric pipe union. These are available at most plumbing stores. *This type pipe connector makes it easy to put several antennas on one pipe and insulate them from one another. These dielectric unions have a built in spark gap which makes the whole thing a fairly good lightning rod.

The two meter ground plane is constructed on a one inch pipe cap as shown in the Antenna book. The inverted dipole is also right from the book. I have a twenty meter dipole, but one can be put up for any band.

A five foot section of one inch pipe was used between the ground plane and the vertical here, but any length can be used to get the height you want. Although too much height might get you into support problems.



The dialectric pipe union.

The inverted dipole can be used to help support the tower against prevailing winds.

A hook is installed just below the ground plane for hanging the dipole.

The coax from the top two antennas cannot be run down the vertical, but should be run off at as near a right angle as possible. All three antennas are fed with 52 ohm coax, but each must have its own feed line.

The antenna is held to the side of the house by two snap-in wall mounts from Allied Radio. The weight of the whole thing rests on the bottom dielectric union and the ground pipe driven into the ground.

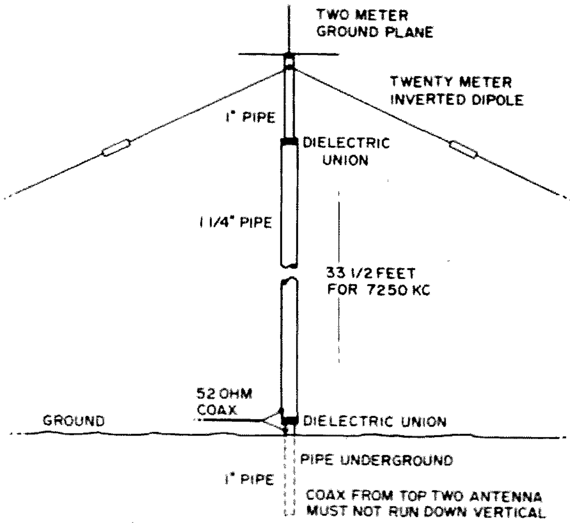
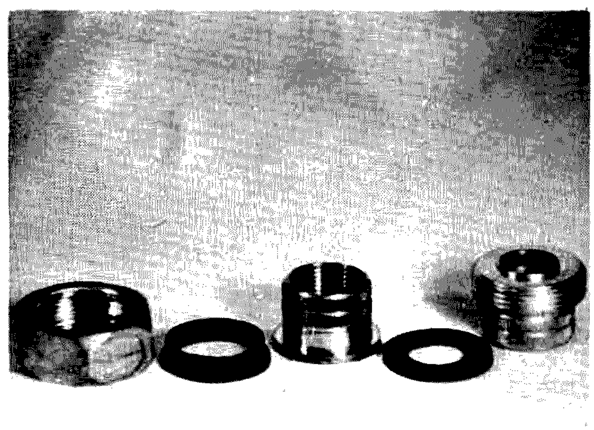


Fig. 1. Assembly of the antenna.

Each of the dielectric unions are one and one quarter on one end and one inch on the other. The one inch pipe driven into the ground can be any length to give a good ground and plenty of support. Here it is about eight feet long and is next to a good well. The ground is always moist, which helped in driving in the pipe.

The vertical must be cut longer than a normal vertical. Maybe because of the end effect caused by the pipe on top. Mine is thirty three and one half feet tall and is resonant at 7250 kHz.

...WA8IYL



Breakdown of the parts of the dialectric pipe union.

*Capital Manufacturing Co., Columbus 16, Ohio. Epco Dielectric Unions, Cleveland 9, Ohio.

Review and test of the Caringella ACP-1 Compressor-Preamp

John J. Schultz, W2EEY/1
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Mystic, Connecticut 06355

The ACP-1 is available in either kit or assembled form from Caringella Electronics, P.O. Box 327, Upland, California 91786.

The Caringella unit offers some unique features as an audio compressor. It is available at reasonable price in both kit and wired models.

One hears and has read about so many audio compressors, both commercial units and those described in various magazines, that the tendency is not to get particularly excited when another unit of this type appears on the scene. This was my initial reaction when I started to review the Caringella ACP-1 unit. However, upon some study of the compressor circuit and particularly after I had built and tested the unit, I felt that it had various unique features that made it well worth a detailed review.

Fig. 1 shows the schematic of the ACP-1 unit and the table below gives the "dry" specifications on the unit. I use the word "dry" to describe the specifications because they are technically accurate, but they give only a static presentation of the performance to be expected from the unit. A better illustration of the performance of which the unit is capable is shown in **Fig. 2**. This graph shows quite clearly the large compression range over which the unit is effective.

Circuit Description (Fig. 1)

Five transistors and one diode made up the semi-conductor compliment of the ACP-1 unit. The input stage, Q1, is a silicon N-channel FET (Texas Instruments 2N3819).

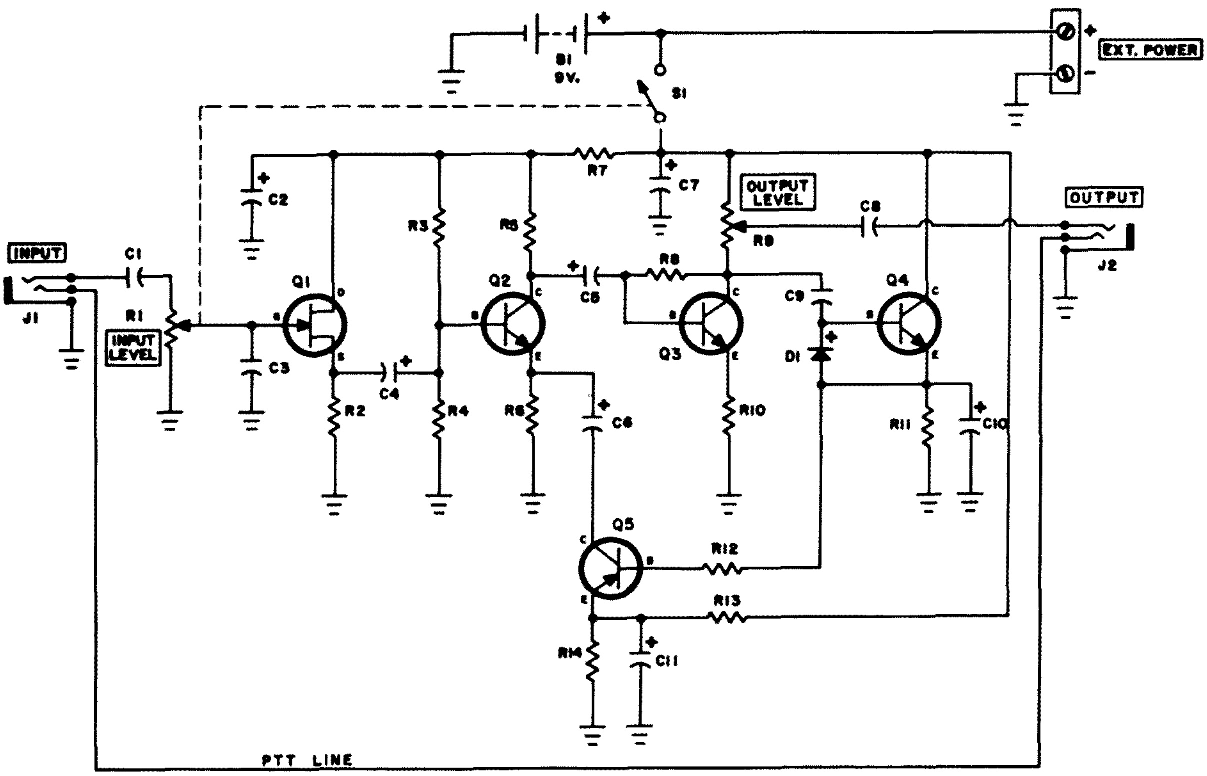

Fig. 1. Schematic and performance specifications for the ACP-1.

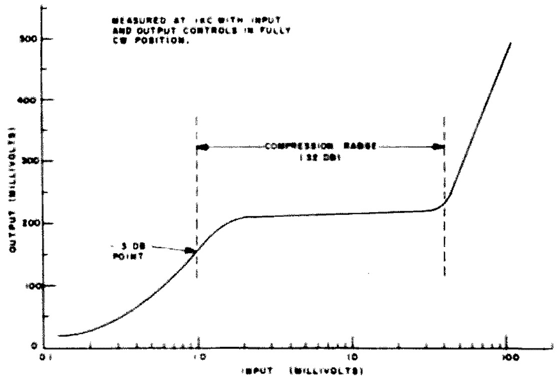

Fig. 2. Extreme compression range of the ACP-1 is illustrated by this graph.

This unit is an extremely low-noise device and, therefore, input noise from the "front-end" of the compressor is negligible. The 2N3819 also provides a very high input impedance for this first stage. R1, a 1 megohm potentiometer, serves as the input level control and is located on the front panel of the compressor.

Transistors Q2 and Q3 are NPN silicon devices used as common emitter amplifiers to boost the audio signal coupled through the source output of Q1. The emitter swamping resistor of Q2 is bypassed through C6 via Q5 in a circuit arrangement which provides the basic compressor action. The emitter swamping resistor of Q3 is not bypassed and the stage operates in a slightly degenerative mode.

The output signal is developed across R9, a 5K ohm potentiometer which also serves as an output level control mounted on the back panel of the ACP-1. Regardless of the setting of R9, however, part of the output signal is coupled through C9 to diode D1 and transistor Q4. D1 rectifies the audio signal segment coupled through C9 and the resultant dc current is amplified by Q4, another NPN silicon transistor.

The amplified dc output of Q4 is used to control Q5, a PNP germanium device. Q5 is operated in its linear resistance region and acts as a current-sensitive variable resistor. This variable resistance is in series with C6, the emitter bypass capacitor for Q2. The gain of Q2 changes as the resistance of Q5 changes since the effect of C6 is reduced and the stage operates in an increasingly degenerative mode.

Circuit Features

One of the significant differences over many other circuits that one notes in the foregoing description is the use of the 2N3819 FET input stage. The use of this FET provides two significant features. One is very high input impedance so that a correct match is provided to the usual hi-z crystal or dynamic microphone. Low impedance microphones require the use of a matching transformer for proper operation. The other significant feature is that the extreme low-noise characteristic of the FET prevents the noise buildup or noise "rush" that is common between speech pauses when using various other compressor circuits. The lack of noise "rush" is also partially due to the well chosen release time of about two seconds.

Another significant feature is the use of Q4 as a dc amplifier stage. The use of this extra stage provides a greater compression range than is possible when only a diode or dual-diode voltage multiplier is used to control the variable resistor element in a compressor. R11 and C10 determine the compression release time while the voltage divider formed by R13 and R14 set the output level at which compression action starts.

Construction

All the components supplied were of high quality and a complete set of plugs and battery connectors are included (the battery itself is not supplied). The components all mount, except for the panel controls, on a heavy duty glass epoxy printed circuit board. The enclosure has a gloss brown speckle finish with white lettering. Provisions are made for internal mounting of a 9 volt transistor-type battery.

The assembly, circuit and operating details are all described in a 3½ page folded sheet. Following the instructions given, the assembly time required was somewhat less than two hours.

Operating Experience

The unit was tried with a SB-34 transceiver and crystal microphone (as well as a SBE microphone through a matching transformer for the input). The SB-34 has no alc circuitry and particularly outstanding results were obtained. Stations worked consistently reported an apparent 6-8 db increase in signal strength when using the compressor. Audio reports were clean and no appreciable noisiness from use of the compressor was reported. It was interesting to note that the tubes used in a linear with the SB-34 started to redden slightly, a sure sign that greater average power was being generated. Transmitters having a usual 8-10 db range alc circuit should exhibit only a slightly less improvement when using the compressor.

SPECIFICATIONS

VOLTAGE GAIN: 40 db minimum

COMPRESSION RANGE: 30 db minimum

FREQUENCY RESPONSE: Flat 20 to 20,000 cps (without RFI filter)
Flat 20 to 5,000 cps (with RFI filter)

INPUT IMPEDANCE: 0.5 megohm

OUTPUT IMPEDANCE: 5K ohm

ATTACK TIME: 1 millisecond maximum (time required to reach full compresion from zero compression)

RELEASE TIME: Approximately 2 seconds (time required to reach zero compression from full compression)

SEMICONDUCTOR COMPLEMENT: 1 — n-channel silicon FET
3 — npn silicon transistors
1 — pnp germanium transistor
1 — germanium diode

FRONT PANEL: Input level control with on/off switch, 3-way phone jack for input connection

REAR PANEL Output level control, 3-way phone jack for output connection, terminal strip for external power connection

POWER REQUIREMENTS: 9 VDC to 12 VDC. 3 ma. to 5 ma.

DIMENSIONS: 4¼" wide x 2½" high x 3½" deep

MISC: Furnished with two matching phone plugs, high quality MIL-type glass-epoxy printed circuit board, and easy-to-follow instructions

SHIPPING WEIGHT: 15½ oz.

PRICE: Model ACP-1 KIT $18.50*
Model ACP-1 WIRED $26.50*
F.O.B. Upland, California
less battery

The unit was tried both using an internal battery and powered by the 12 volt line in the SB-34. In the latter mode, for best stability, it was found necessary to use a 100 pf bypass and a 100 ohm/50 μf decoupling network on the 12 volt line to the ACP-1. The need for these components may partially have been due to the use of an unshielded cable between the SB-34 and the ACP-1.

Summary

The ACP-1 confirmed its specifications as a superior compressor unit. The emphasis in the ACP-1 kit seems to be more on hardware rather than software but, in this case, the emphasis is certainly correctly placed.

The output level control is generally not necessary when the unit is used with a transmitter having a microphone gain control. This "surplus" control space on the back panel plus the space still available in the ACP-1 enclosure sorely tempts one to compact into the enclosure other small transistor or IC station accessories, such as tone generators, VOX or keyer units. I, in fact, easily put an IC keyer that was unhoused into the enclosure and there is still room for a VOX unit.

...W2EEY/1

Promoting vhf

An excellent way of promoting contacts, friendship, and interest in ham radio on the vhf bands is to collect a list of operators on a particular band and mode. In many areas the vhf bands are sparsely populated and for this reason there is much dependence upon ground wave contacts to keep the bands alive. Collecting the call, handle, and city of all known operators within a 200 to 300 mile radius and sending a copy to each new operator along with your qsl creates a feeling of comradeship which can't be gotten any other way. The new man appreciates being a part of the gang, knowing everyone's handle, and what to expect in the way of contacts.

Keep your list current by adding and deleting as soon as changes are made and making new copies at regular intervals. The list will be most useful if some blank lines are left for additions to be made between issues.

Usually there is someone in the area who has access to a copier or mimeograph, who can make copies at little or no cost. Postage costs the same as a qsl when the qsl is stapled inside the list and the two are sent together.

William P. Turner, WAØABI

ATV Video Modulator

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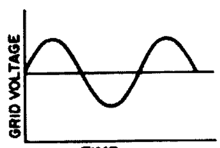
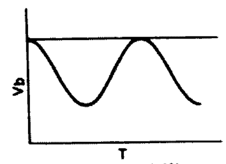
Temple City, California 91780

Here is an easy way to put a 435 MHz transmitter on the air for ATV. This one-transistor video modulator will provide 10 MHz wide high resolution pictures when used with a good camera and a 450 MHz FM transmitter strip. Any of the FM transmitters that have a 5894, 6907, 6939, etc., dual tetrode, or home-brew rigs using 4 x 250's will work without sacrificing their FM audio capability. The AM or FM mode will depend only on which modulation jack is plugged in. AM phone can even be used by plugging in 1 volt p-p audio from a microphone and preamp.

The input accepts the standard 1 volt peak-to-peak positive going sync signal from the TV camera 75 ohm coax to a SO-239 UHF connector. A 100 ohm pot in parallel with the input impedance to the transistor amplifier approximates the required 75 ohm resistive termination. This is important as any SWR or roll off encountered as the modulating frequency increases will decrease the resolution. The transistor amplifier has a voltage gain of about 50, which is the maximum necessary for the largest tube–4 x 250. The 100 ohm video gain pot varies the negative swing as seen by the final grid. A .001 capacitor by-passes the 100 ohm emitter to give a boost to the higher frequency component of the video. The transistor has a ft of 25 MHz and a collector-emitter breakdown voltage of 300V yet costs only $1.21 each from Allied Radio or your RCA distributor. It's a 6AQ5 without filaments.

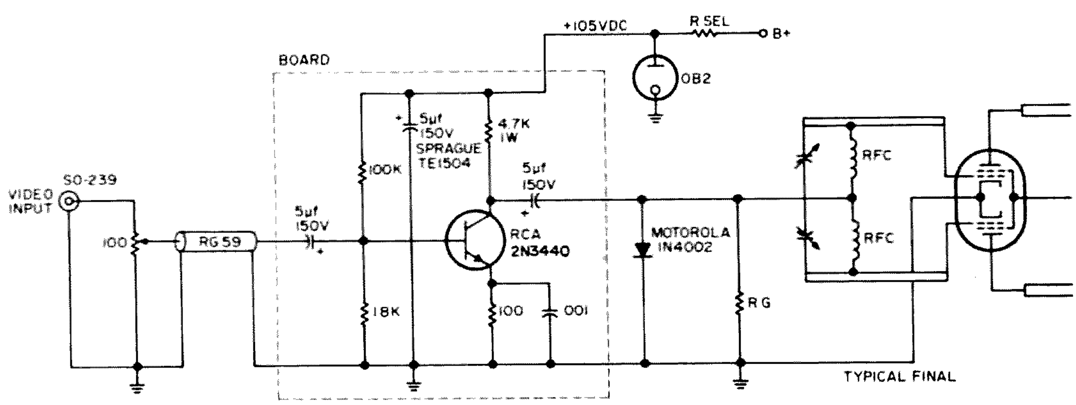


NORMAL AC ON THE BIAS VOLTAGE



DC RESTORED AC ON THE BIAS VOLTAGE

The output of the amplifier is coupled to the control grid of the final tube. The silicon diode dc restores the video so that maximum



Schematic for 435 mhz ATV transmitter.

power always occurs at the sync tips and gives a better contrast picture. This also lets you run the final at the highest class C continuous FM ratings.

Construction

The modulator must be mounted directly at the final grid to minimize *rf* pickup. The amplifier components should also have short leads. The components can be mounted on a copper, fiberglass, vector, or printed circuit board (PC board available from author—$3). The lead from the 5 µf coupling capacitor to the rfc should not be longer than ½". Take off any by-pass capacitor that may have been at this junction. Rg is existing grid bias resistor typically 10 to 22K. The B-plus dropping resistor is selected for a 20 ma flow from the lowest voltage source.

Operation

Plug in the vidicon camera,[1] flying spot scanner, or color bar generator and adjust the gain pot for best received video at a distant location. Your own set may give a false picture from overloading. Get a friend to pad down his UHF TV converter with 2 pf added across each variable tuning capacitor to look at your picture. He can describe your picture as you turn the gain pot, antenna and lens. The Blonder-Tongue BTD-44 converter makes a good 435 MHz ATV converter as all it takes is to screw the two variable capacitors all the way in and go into the TV set on channels 2 or 3 rather than 5 or 6. This will move reception up about 12 channels and 435 MHz will appear just below channel 14.

To keep sync buzz out of phone receivers and to keep modulation bars out of the pictures, I suggest choosing 435 MHz as the ATV carrier frequency. AM phone usually occupies 431 to 433 MHz and FM'ers 440 to 450 MHz. If you later add 4.5 MHz subcarrier audio[2] it will be still in the ATV frequency range at 439.5 MHz. FM transmitters such as the RCA CMU-15 get about 10 watts output and enable you to send a picture to most any station you can talk to on 2 meters with 5 watts. 144.45 and 146.1 MHz are usually used as the ATV calling frequency since recognizing an ATV signal is difficult unless the antennas are orientated right. The Cushcraft 16 element colinear seems to be the best antenna for ATV because of its reliable gain and bandwidth. Hope to SEE you on the air.

...W6ORG

1. *ATV Anthology*, available from 73.

2. *FM Subcarrier Generator for Ham TV*, W6ORG, 73 April 1967, P. 46.

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VHF, FET, More of

Not being a writer, I found this undertaking to be something short of impossible. But, being a ham fortunate enough to have two or three home spun circuits that work very well, I felt I had to share my joy with others.

The units described here are all based on the use of inexpensive plastic FET's. The designs are by no means mine but rather ideas collected from many sources. The principle source, and that which prompted my experimentation with FET's, was an article written by W6AJF, Frank Jones, in the Sept. issue of 73 for 1968.

My first endeavor was to construct a preamp for 436 MHZ ATV. Being primarily interested in signal gain, I constructed a two stage unit employing the Union Carbide UC734E epoxy field effect transistor. This unit consisted of a neutralized grounded source coupled to a grounded gate. I used sockets in this unit mainly because I am new at transistor construction and didn't want to damage them while soldering. Also, as Mr. Jones points out, this allows the selection of the best transistor for the first stage. I also shielded the drain from the source on both transistors and this proved to be very useful in preventing feedback.

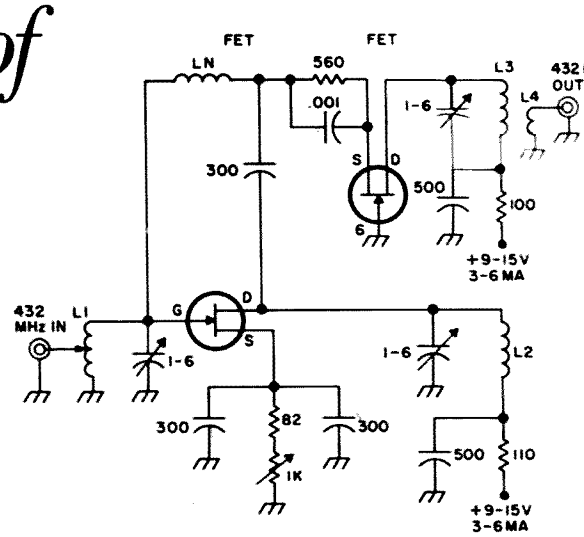

Fig. 1. 432 mhz FET preamp.

Parts List

LI - 1" long x ¼" wide copper strip. Center tapped.
L2 L3 - 1½" long x ¼" wide copper strip.
L4 - 1" #18 wire coupled to L3.
Ln - 2-4 turns #22 ¼-3/8 long x 3/16" diameter slug tuned.
FET - UC734 Union Carbide.

After the usual mistakes were corrected the preamp started to perform. Once the first stage was neutralized, which wasn't too difficult, I had a very hot preamp.

This was fed into an old uhf TV converter employing just a crystal mixer, but retuned to cover the 435 MHZ band. The results were excellent. Local signals, as well as one

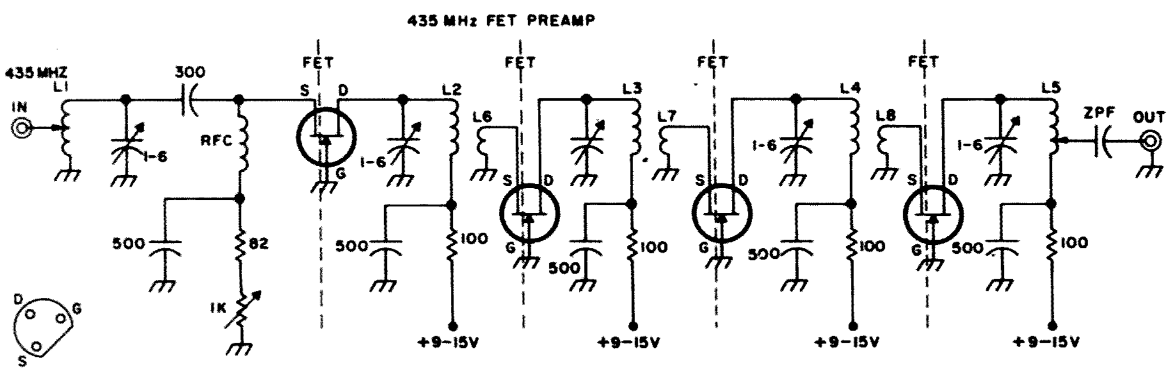

Fig. 2. 435 mhz FET preamp.

Parts List

LI - 1"x¼" copper strap - center tapped.
L2-L3-L4-L5 - 1½"x¼" copper strap.
L6-L7-L8 - 1" #18 wire parallel to cold end of output strap.
FET - Union Carbide UC734-E.

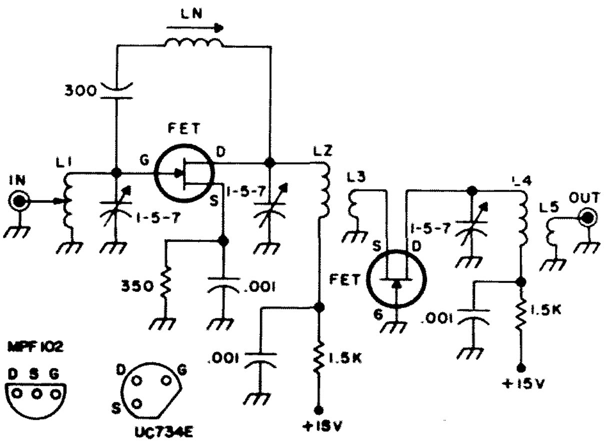

Fig. 3. 2 meter FET preamp.

Parts List

L1 - 4T #20 5/16" dia. x ½" L
L2-L4 - 5T #20 5/16" dia. x 7/8" L
L3-L5 - 2T pickup loop
Ln - 8 turns #26 ¼" slug form
FET - UC734E Union Carbide (1st choice) – mpf102 Motorola

about 100 miles distant, were received with S9 copy. Please note the only antenna at this time was a home brew 3 foot reflector with a dipole in the center.

After such astounding success with the two stage unit, I "naturally" concluded that four stages would be better.

I proceeded to build another preamp of that same configuration except for two additional stages of grounded gate. WOW, was that unit loaded with problems. I spent several weeks trying to tame it down but achieved little success. I then changed the input stage to a grounded gate and experienced the same problems. It became apparent that my shielding was inadequate so I put shielding on top of shielding until I had completely enclosed each tuned circuit. This cured the problem very well. I realize now that the circuit as I had originally built it would have worked very well if I had been much more careful in the way I had used the interstage shielding.

Both 436 MHZ circuits employed the UC734E FET mounted in sockets. Copper clad board was used for the base and also for the between stage partitions. Capacitors are all Arco # 400 miniature trimmers which are very inexpensive, but do a very good job.

It should be pointed out at this time, that all the accepted vhf techniques should be employed in this type of construction or success will be very limited. Shortest possible leads, good bypassing, and adequate shielding as shown above, are all essential at these high frequencies.

After getting both of these units working, I constructed a two meter preamp utilizing the MPF102 in a grounded source to grounded gate configuration. (This FET was used because I ran out of the UC734E.) This preamp required very little adjustment to get it working. It also seems to outperform my 417A preamp as far as noise figure vs gain. I say "seems" because I don't have the know-how or the necessary equipment at this time to perform noise figure tests.

As I have tried to indicate, I am no engineer and these units evolved out of a cut and try approach.

I heartily encourage any one needing a good preamp to try one of these because they are not at all difficult and require a minimum of parts. I suggest though, that before attempting to build one, the reader should refer to the very excellent article by Frank Jones in the Sept. 73 issue. His article covers the basics behind these preamps very thoroughly and takes care of what I have left out.

...K6KTP

A Simple

Scope for RATT Monitoring

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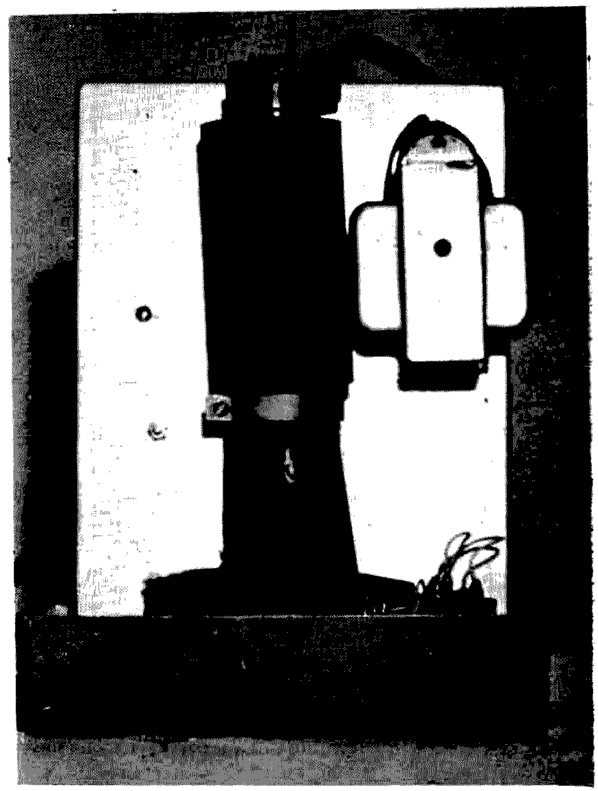
Tuning in an RTTY signal is virtually impossible unless some form of tuning indicator is used. The most common indicators are the tuning eye tube, meter, and cathode ray tube. Of these, the most flexible by far is the cathode ray tube. In addition to providing tuning information it can be used to identify interference and check on proper transmitter operation.

For some reason, most amateurs shy away from building oscilloscope indicators. Actually, they are no more difficult than any other electronic project. This little indicator is about the ultimate in simplicity. This is due to the availability on the surplus market of the 902-A cathode ray tube. This tube is available for about $3.00. It has a deflection sensitivity of 90 V/inch making it

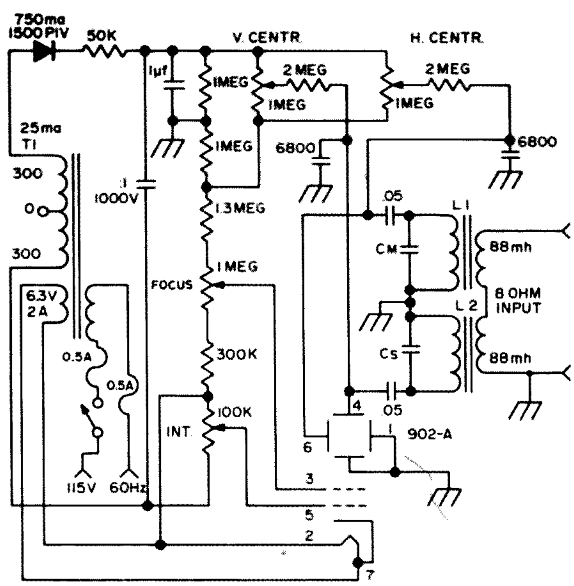


Top view showing water pipe shield installed. Note the small foam rubber cushion at the front of the tube.

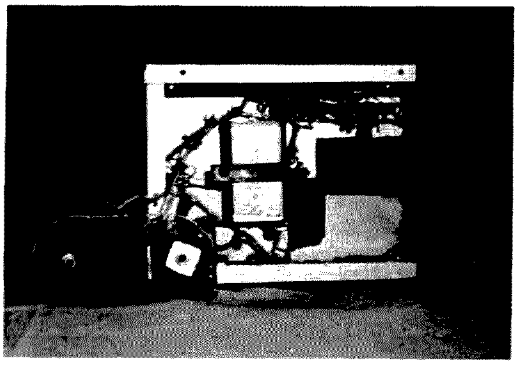
possible to obtain adequate deflection without amplifier stages. In addition, its high voltage requirements are modest, allowing the use of a small cheap power transformer (300-0-300 v) in a half wave rectifier configuration.

The scope was constructed on a 6 x 9 x 2 inch aluminum chassis. The circuit (Fig. 1) was divided into two sections. The power and oscilloscope control components were mounted on the panel and chassis. The input transformer – tuned filter networks were constructed on a 2 x 5 inch piece of vector board which was mounted underneath at the rear of the chassis on stand-offs. Leads to this board should be long enough to allow the board to be slid out of the chassis for tuning.

Due to the small size of the cabinet it was



Schematic for the Simple Scope.



Bottom view showing filter board removed for tuning.

necessary to mount the transformer with the core parallel to the axis of the cathode ray tube. This produced an un-wanted deflection. The cure was a tube shield made from a 4 inch length of 2 inch diameter galvanized water pipe. After cutting, the shield was de-burred and painted black.

All my receiver output lines have an 8 ohm impedance whether they are from the hf communications receivers, or the vhf FM system. A standard 88 mH toroid is used for a combination tone filter and step up transformer. To match the 8 ohm line a primary winding of 35 turns of No. 22 enameled wire is wound over the existing turns of the toroid.

After checking the wiring, turn the scope on, allowing it to warm up. Advance the brilliance control until a spot appears, then sharpen the spot with the focus control. Center the spot with the centering control. Connect an audio signal generator to the input. Remember, most audio oscillators have a 600 ohm output impedance, so a matching transformer should be used.

Now you are ready to tune the filters. There are several ways to do this. The results obtained by using a counter to check the frequency of your audio oscillator are well worth the trouble of obtaining the use of

this instrument. If you are active in Army MARS a counter can usually be obtained from your nearest test equipment pool.

The easiest way to tune the filter is to use a value of 0.033 uF for the space capacitor. With your oscillator set at 2975 Hz tune the circuit to resonance by removing turns from the toroid.

About 4 turns per Hz is a good rule of thumb. Next tune the mark filter using a 0.066 mF capacitor to start with, and the same procedure. The audio oscillator should be set to 2125 Hz.

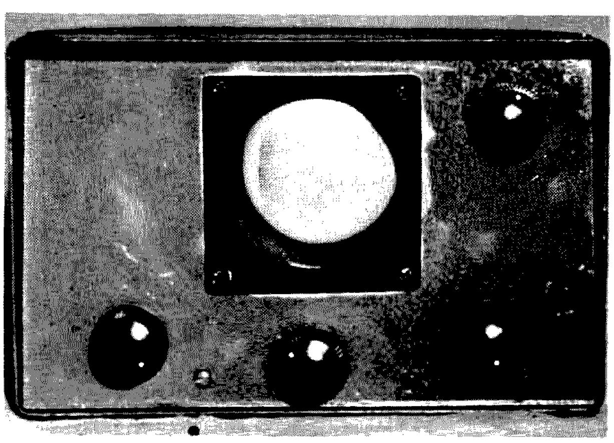
An alternate method is to substitute capacitors until the desired frequency is reached. This is simpler than removing turns only if you have a large selection of capacitors.

Remember in both cases, a good grade of mylar or paper capacitor should be used.

If you can't get your hands on a audio oscillator, the output from a friends AFSK oscillator can be used.

In operation the input line is bridged across the 8 ohm input to the TU. The receiver BFO is turned on and the desired RTTY signal tuned in until a distinct cross is obtained on the CRT. The audio gain is adjusted to obtain the desired height.

. . . W6JTT



Front view of the "Simple Scope."

Curtain Rods, Coat Hangers, and Control Links

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One of the recent trends in amateur radio is the rapidly increasing number of six and two meter FM repeaters. Since FCC requirements specify the use of a control link above 220 MHz, and since the 450 MHz commercial band "splitting" has rendered many older units obsolete, many repeaters utilize the 420-450 MHz band for the control link and for satellite transmitters and receiver links. Prime consideration must be paid to the antenna system used in these links. The master control link must use directional antennas, and directional, gain antennas are desirable for satellite links.

Although many of the repeaters are backed by large amateur groups with excellent financial position, others are maintained by small clubs or individual groups on a limited budget. These small groups must rely on donations of time and material to establish and maintain the repeaters. Since there are few 450 MHz antennas gathering dust in amateur shacks which could be donated to the repeater, these groups often make do with cut-down 2 meter ground-planes and similar antennas. The purpose of this article is to describe a yagi antenna which is very inexpensive (cheap!) and easy to construct, which will fulfill the antenna needs of these repeater links.

The basic items needed are described in the title: Curtain rods, coat hangers, a piece of threaded rod, and a piece of aluminum tubing. The boom is constructed from a cafe type of curtain rod. These rods come in varying sizes. Since there are two sections to each rod (one sliding inside of the other) two antennas may be made from each rod. The rods which extend to 48" and are brass plated make excellent booms for 420 – 450 MHz. All parasitic elements are constructed from coat hanger wire and the driven element is constructed from a combination of 1/4" threaded rod stock and 3/8" aluminum tubing. The parasitic elements are soldered directly to the boom and the driven element attached by a single No. 10 bolt. The antenna may be easily mounted either vertically or horizontally and weighs less than two pounds.

The first step is determining the spacing between elements and the length of the elements themselves. This may be done with the use of the various antenna handbooks. The antenna described in **Fig. 1** will work well at the high end of the band where most links operate. If desired the spacing and number of elements may be varied to result in more gain, better front-to-back ratio, etc. if desired. The dimensions in **Fig. 1** were chosen to facilitate the boom material available while giving good gain without critical adjustment.

Lengths of coat hanger wire should be cut to the desired length (three coat hangers will provide enough material for the antenna in **Fig. 1**). Next scrape the paint from about ½" either side of the center of each element.

The driven element should be constructed from a piece of 3/8" aluminum 2" longer than the calculated length of a ½ wave driven element. The extra is to allow 1" to be flattened and turned up at each end which will be drilled to hold the remainder

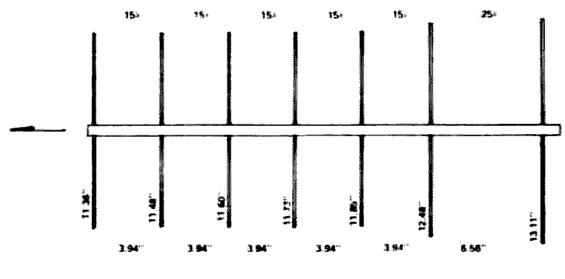


Fig. 1. Dimensions of antenna. 10.5 db measured over ground plane at Denton, Texas, Repeater Link.

of the driven element. The remainder of the driven element is made from two sections of ¼" threaded rod the length of which total the length of a ½ wave driven element. When these rods are mounted as in **Fig. 2** the amount of rod taken in attaching a nut to hold it to the remainder of the driven element will allow a gap in the center of the antenna. To this place the 300 ohm (don't worry about matching, I'll cover this later) twin-lead will be attached.

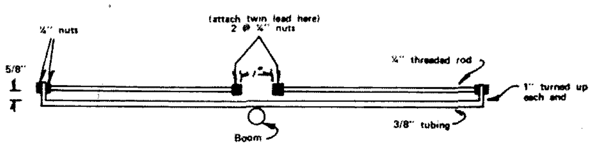


Fig. 2. Driven element.

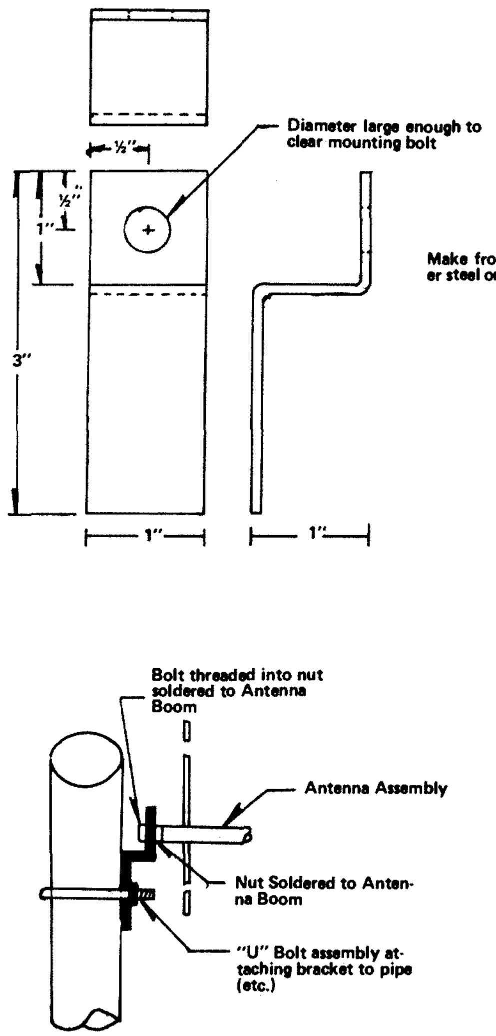
For most of the remaining steps a soldering iron or gun with a fairly high wattage rating will be needed for best results. The antennas in the accompanying photographs were built with an old 250 watt gun. No problems were encountered while soldering.

A close look at the curtain rod will show that it is basically a brass plated sheet of steel rolled into a cylinder. Since there is no weld at the seam the rod can be distorted by twisting. To overcome this the seam should be spot soldered every four or five inches. Most rods have a coating of laquer which should be scraped away at each spot. The whole operation takes about five minutes for the first boom, and less time after you get the "hang of it."

The next step is to attach a nut to the open end of the boom (as in photograph) by soldering. A 5/16" nut and bolt work quite well for most booms. The purpose of this nut is to hold the bolt which in turn mounts the antenna. If care is taken in soldering, the joint is quite strong and will support considerable weight.

Next the parasitic elements should be soldered on the boom 180° from the seam. Again make sure that the proposed joint is scraped clean. The elements may be aligned by letting one end rest on the bench as they are being soldered. Since the wire is relatively soft the remaining distortion may be easily eliminated.

The driven element is attached by a bolt inserted in a hole drilled through the boom and the driven element. The feed line is attached to the driven element as shown in the photographs. Finally the antenna may be mounted by inserting the bolt through a drilled hole into the nut soldered on the reflector end. Or, as an alternate the antenna may be attached to a small bracket (as in Fig. 3) and the bracket attached by "U" bolts or other means.



• Fig. 3. Bracket details, and assembly sketch.

The reasoning behind the use of a folded dipole driven element and 300 ohm feed line may be obscure to some new comers to the UHF bands. The reasoning is simple: 300 ohm twin lead is cheaper than, and has much less loss than most coax (and all coax within the budget of most amateurs). Also, it is easily available and fairly easy to work with. The main restrictions is to avoid sharp bends and to keep it spaced from other objects. This may be accomplished by standoff insulators which are easily obtained.

All obsolete commercial UHF equipment commonly available utilize a coax feed system. To match the 300 ohm feed line to the transmitter and receiver a balun must be built. This may be constructed from either a ½ wave length of coax or a 1½ wave length

of coax. If the dimensions in Fig. 4 are followed, do not use foam type of coax. If it is desired to use foam coax then the length must be modified to allow for the increased

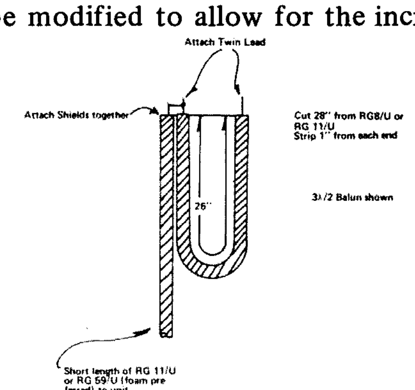
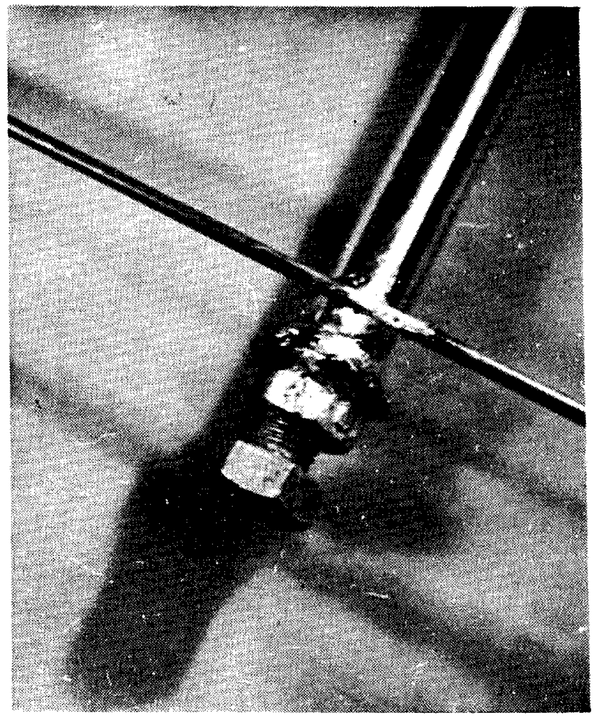


Fig. 4. Balun dimensions. Formulae (length of shield) in inches. V = velocity factor (.66 for regular coax):

$$\lambda/2 \text{ Balun} = \frac{11811}{\text{FMH}_z} \times V \times .5$$

$$3\lambda/2 \text{ Balun} = \frac{11811}{\text{FMH}_z} \times V \times 1.5$$



Mounting nut details.

velocity factor. The formula for calculating the length is also part of Fig. 4.

Optimum gain in the antennas may be obtained by adjusting the spacing and element lengths as in any other type of yagi. However, formula derived lengths and spacing are usually satisfactory. Also, once the spacing has been determined for the first antenna, each additional antenna may be built with the same dimensions.

The prime advantages in using this antenna are the low cost (approximately 25 cents each) and the ease in mass producing several for use at remote receiving and transmitting sites. In the case of two or more remote locations it may be desirable to utilize a non directional antenna at the central site and directional antennas (as described herein) at the remote sites. In the latter case, the over all system gain will not be as great as when using directional antennas for both halves of each link, but the improvement over ground-planes at each end is remarkable.

One last note: After completion of the antenna it is desirable to coat the entire antenna with clear Krylon to prevent corrosion, especially at points which have been scraped clean to facilitate soldering. By the way, this antenna does not have to be used only on control links. It will do a fine job when used for other amateur work.

...K9STH

An Antenna With a New Twist

After reading the article on the Spiralray antenna[1] I decided to make one. I now work 2 meters AM and FM, so I thought this would be a good antenna to try, since AM is normally horizontal polarization and FM is vertical. While I usually use a 3 element vertical colinear for the FM because of its all directional gain, a beam is sometimes very useful.

Like most hams, I look around for the easiest and cheapest way for my first try at something. I just happened to have a Cush-Craft 11 element beam on hand which hadn't been put up yet, so I decided this should do the job. Although the Fig. 1 and the photo are for the 11 element beam, it will work with any beam on hand.

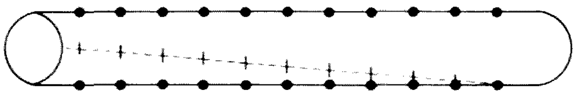
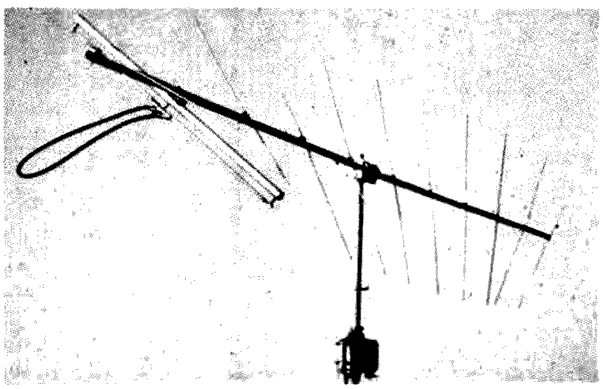


Fig. 1. Marking the boom for the new placement of elements.

The first thing to do is to number all the elements so they will go back in the right place. Then remove everything from the boom. To get the proper twist in the elements take a piece of string and put one end



An antenna with a new twist.

through the existing mounting hole for the reflector and fasten it tight. Then run the string the length of the boom and tape it so that the end is ½ way between the existing mounting holes for the forward director. With a center punch make a mark for the new mounting holes along the string line and even with the old ones. The new holes could be made with a hand drill but I would recommend using a drill press so that they will be straight.

All that remains is to re-install the elements, check the swr, and put it up. Reports show excellent results on both AM and FM, with either vertical or horizontal polarization.

Don Marquardt, K9SOA

(1) *73 Magazine*, January 1965, page 68.

Facsimile and the Radio Amateur Part II

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The response to my article on facsimile equipment[1] was most surprising and encouraging, with letters arriving from all parts of the United States seeking more information about the equipment and operations.

In the first article, mention was made about Western Union Telegraph Company donating some of its older models of the Interfax equipment to radio amateurs. Judging from the letters received, some of the amateurs did acquire some of the machines and are looking for information about schematics and facsimile paper for the Interfax equipment.

Through the courtesy of the Western Union Telegraph Company, schematics will be furnished, at no cost, by writing Western Union Telegraph Company, 60 Hudson Street, New York City, attention of Catalog and Specifications Library. Be sure to mention the model numbers of the Interfax equipment for which you need schematics. Also, this company will sell the facsimile paper for the machines at $1.56 a roll. This paper can only be purchased from the offices of the technical managers of Western Union. These offices are in the large cities of the United States such as New York City, Los Angeles, Chicago, Washington, etc. If you wish the address of the technical manager in your area, contact the manager of the Western Union office in your town and he will give you the needed information.

The most common question in the letters received was "Where can I secure facsimile equipment if I don't belong to MARS?" The answer to this is to check the advertisers in 73 as several advertisements appeared in the December issue offering facsimile equipment at very reasonable prices. Watch the ads each month as more of this equipment is gradually reaching the surplus market. Another source where this equipment can sometimes be purchased is at the retail surplus stores at military bases. The most likely place to find this surplus item would be in these stores at Naval Shipyards, Naval Air Stations, Air Force and Marine Air Stations.

Another question which was asked, "What frequencies are weather maps transmitted on?" There are a number of radio weather stations in both Canada and the United States. For frequencies, check with your local weather bureau and also write the U.S. Weather Bureau, Suitland, Maryland, which is headquarters of all U.S. weather stations. You will find more of these weather stations after you have become accustomed to the tones of facsimile on the radio bands.

In one letter the question was "Are there clubs or groups that are interested in facsimile and is there a magazine or manual published on the equipment?" On the first part of this query, I have not heard of any groups or clubs experimenting with facsimile, but would like to find out if there are any so the information could be passed on to others. A list could then be published of these groups or clubs so that information on facsimile could be exchanged. In reference to the second part there are no special magazines or manuals published for the radio amateur about facsimile equipment and operations. There possibly may have been articles published in the amateur radio magazines in past years, but I believe this article and those previous[2,3] on facsimile are the only ones of recent date. If there is enough interest in facsimile, allowing for the letters I have received, a series of articles could be prepared for later publication. Write *73* and let them know if you want more information published on this subject.

With slow-scan television legal on the low bands, facsimile may be the next mode of communications to follow in the near future. All it needs at the present time is enough interest by the radio amateurs to show the Federal Communications Commission, by petition, that facsimile will contribute to the state-of-the-art. It has been proven by Paul Blum, W2KCR, in 1957 and myself in 1968 that facsimile operations by the radio amateur could be a great morale booster for our servicemen in all parts of the world. With these operations being on record there is no doubt that other radio amateurs will continue to carry on projects to expand the interest in facsimile.

I wish to thank the many radio amateurs

Getting Your Extra Class License

Part V - Transmission Lines

Staff

Last month we examined some of the basic principles upon which antennas and radio-wave propagation operate, and promised to continue the discussion in this issue.

This time we'll to into an area which has been the subject of possibly more discussion—and fewer hard facts— than any other in all radio, amateur or otherwise. What we'll come out with won't be new—but we may offer you some new light on it along the way.

The questions from the FCC Extra Class study list which we'll be covering are:

22. Can a lossy transmission line be used to transmit signals? Explain.

32. Explain the properties of a quarter-wave section of radio-frequency transmission line.

44. What are the current and voltage characteristics along a transmission line when it is matched, and when it is mismatched?

55. A 70-ohm transmission line is connected to a 35-ohm antenna. Calculate the standing wave ratio (SWR), the reflection coefficient, and the percent reflected power. If 10 amperes are flowing in the antenna terminals, what is the current in a transmission line node?

79. Describe briefly some well-known types of antennas and antenna systems used by amateurs which do, and do not, reduce harmonic radiation.

As usual in this series, we'll rephrase these five questions into new ones which will hopefully include all the subject matter of these five together with enough additional related material to provide complete coverage of the subject.

Four of the five questions deal with transmission lines; only one deals directly with antennas. A logical first question for us, then, is "What Is A Transmission Line?" From this foundation, we can then ask "What Are The Major Characteristics of a Transmission Line?" We will find that one of the major, although secondary, characteristics is our old friend SWR; this leads to our third question, "What Is a Standing Wave Ratio?"

By this time we should have waded through more information than most of us ever want to know about transmission lines and their properties, so we can return to antennas. The major properties of antennas were covered last month, but with the main emphasis being placed upon their directional effects. Let's turn now to their frequency-sensitive sides and ask "How Are Operating Frequency and Antenna Design Related?" With that taken care of, we'll close our examination of antennas and transmission lines by determining "What Are The Most Popular Types of Antennas in Ham Use?"

All set? Let's get going.

What is a Transmission Line? Strictly speaking, of course, a transmission line might be considered as a "line that transmits." However, when engineers use the term they mean any line which is conducting electrical energy, and when we as amateurs (or the FCC examiners) use it we usually mean an *rf* transmission line, which is a special type of cable conducting *rf* energy.

Two general types of transmission line are in wide use; they are parallel line, of which the familiar TV twinlead and the open-wire feedline are common examples, and coaxial cable. While coax is probably in wider use because of a number of practical advantages it has over the parallel type, it's much easier to see the theory of what happens in the parallel variety so we will be talking primarily about parallel lines.

Before we do, though, we might as well summarize the advantages of coax; the reasons why they are advantages will come out as we proceed. In a coaxial line, the *rf* is

essentially confined to the interior of the cable and thus cannot radiate so easily. Neither can noise contaminate received signals. Coax is relatively insensitive to its surroundings as well. These three points are the major advantages; counteracting them are the facts that coax is (1) more expensive and (2) has higher losses, in general, than parallel lines.

Having disposed of coax cables for now, let's turn our attention to parallel lines to determine what a transmission line amounts to.

Any line conducting alternating current, at any frequency, loses at least some of that energy by radiation. The radiation is a direct consequence of the flow of alternating currents in the line, which create (or at least are accompanied by) reversing magnetic fields about the line.

A flow of current, though, requires two conductors, and if the two conductors are located very close to each other the radiated energy from one is effectively cancelled by that from the other. The net result is that almost no radiation occurs.

If the conductors are separated an appreciable fraction of a wavelength, however, this mutual cancellation cannot occur. Whenever the size of the circuit is physically such that no mutual cancellation is effective, energy will be radiated.

The terminated or "travelling-wave" antennas we examined last month were examples of "transmission lines," which had only one-way net current flow (ground serves as the second conductor in this example). Such a "transmission line" is an excellent radiator of *rf* energy—if it's big enough.

Mere physical size is not enough, either. The dimensions must be large in comparison to a wavelength. A cross-country power distribution highline fails to do much radiation of its 60-cycle power although it's many miles long, because its conductors are spaced only a minute fraction of a 60-cycle wavelength apart and their fields mutually cancel. A 6-meter antenna, on the other hand, radiates nicely from elements which are much shorter than the distance between highline conductors, and a microwave circuit can provide appreciable gain from a beer can!

Since a transmission line consists of two conductors, which are insulated from each other, then it must have some capacitance between them. In addition, each of the conductors also has some self-inductance, and of course at least a little resistance as well.

Let's look at a very short section of a very long line, such as that shown in **Fig. 1**. In even this very short distance along the line, the voltage between wires is not the same at all points, nor is the current in either wire.

For instance, the current flowing through the wires must by Ohm's Law result in at least some voltage drop across the resistance and inductive reactance of each tiny portion of each wire. That is, the voltage from A to D indicated by dotted line 1 is greater than that from B to C indicated by dotted line 2, because of the two voltage drops—one from A to B and the other from C to D— caused by the current flow.

Similarly, alternating current effectively "flows" through a capacitance, so that the current flowing from E to F is greater than that from F to G, because of the leakage current through the line's capacitance from F to H.

Since this is ac we're discussing, to be theoretically accurate we would have to resort to a set of differential equations—but for all ham purposes it's adequate to think in terms of Ohm's Law for ac. This tells us that the effect of the inductance and capacitance as illustrated in **Fig. 1** upon the voltage and current in the line must be an *impedance,* since only an impedance can relate voltage and current in an ac circuit.

And impedance, like a resistance, is essentially independent of voltage or current. It's determined by the physical characteristics of the device or component, not by the signal that happens to be applied or the devices to which it may be connected.

In the case of our transmission line, the impedance is determined by the inductance and capacitance of each tiny part of the line. Both the inductance and capacitance are distributed over the entire length of the line, rather than being lumped into coils or capacitors, and thus the impedance is an essential built-in part of the line.

Incidentally, this capacitance which helps form the impedance is no theoretical fiction. Should you ever be in need of small precision capacitors, you can cut them to measure from *rf* feedline such as TV twin-lead. All these lines are rated for capacitance in picofarads per inch; simply cut off as many inches as you need. It's a handy trick to keep in mind when

electrically small capacitors are necessary.

What Are The Major Characteristics of a Transmission Line? We've already met some of the characteristics of a transmission line. Its impedance is one of the most important, for *rf* use. But impedance is not the only characteristic—and a length of line lying on the floor has far different characteristics than does the same line when trimmed to dimension and installed in an *rf* circuit. Let's look both at the intrinsic characteristics of a feedline, such as impedance, capacitance, inductance, etc., and also at the effective characteristics or properties of specific lines of special length or with special terminations.

We have seen that the impedance of a line is determined by the inductance and capacitance distributed throughout the line's length. For *rf* transmission lines, the impedance is approximately equal to the square root of the ratio of inductance to capacitance. If the resistance of the wires in the line were absolutely zero, and the leakage resistance of the insulator separating the wires were infinite, then the line's impedance would be exactly equal to the square root of inductance divided by capacitance—and in *rf* lines the wire resistance is low enough and the leakage resistance great enough that we don't get into trouble.

However, the wire and leakage resistances *do* exist, so we can't ignore them completely. They contribute to losses in the line, and so provide a characteristic of the line which is called attenuation. Attenuation in any type of transmission line increases as the signal frequency goes up, because the wire resistance goes up and the leakage resistance goes down with increasing frequency. In most practical applications the attenuation of any line is given as a "decibels per 100 feet" figure; a line rated for 3 db/100 feet attenuation will lose half its power in every 100 feet of length. If you pump a kilowatt of *rf* into a 300-foot length of such a line, you'll get out only 125 watts. The first 100 feet of the line will lose half the input power or 500 watts, leaving only 500 to go on. The next 100 feet will lose half of that remaining 500, and the final 100 feet will dispose of half of the 250 watts which had survived the middle portion.

The attenuation of a line is at least as important as its impedance. The attenuation figures tell you how much power is going to make it through the line, and they also will affect the way in which the line looks to your transmitter—as we shall see shortly.

In Fig. 1, we assumed that the power going through our short section of transmission line was all going from a source to a load. That is, the line was carrying power only one way.

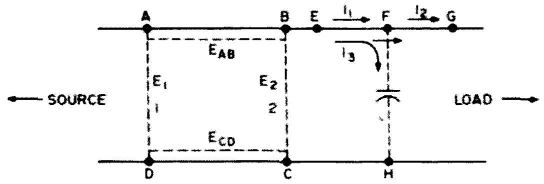

Fig. 1. The most basic physical characteristics of a transmission line are shown here. Assume that current is flowing from the source direction toward the load. The voltage from A to D must be the same as the sum of that from A to B, B to C, and C to D—but current flow through the wires means that the voltage drop from A to B and from C to D will be greater than zero, so the voltage between the two wires at A-D is greater than that at B-C. Similarly, current at point E includes that flowing to charge capacitance F-H, and so must be greater than that at point G. These voltage and current relationships define the impedance and attenuation of any transmission line.

In practice, this is seldom true. The nature of the fields and waves which make up *rf* energy (or any ac energy for that matter) being what it is, a one-way travel of any set of waves will stay one-way only so long as that set of waves stays in the same medium. When any boundary is reached—that is, when anything gets in the way—some of the energy is reflected at the boundary, and at least some of the reflected energy comes back in the direction exactly opposite to its original direction.

It happens to be possible, from a mathematical point of view, to account for *all* the reflected energy in terms of just two sets of waves. One set is considered to be the original set, going "forward" or in the original direction, and the other set is considered to be going in the exact opposite direction. This is known as the "reverse" or "reflected" wave, while the original set is called the "forward" or "incident" wave.

Note that this way of accounting for the energy does not claim that all the energy is actually contained in the forward and reverse waves; we actually do not know for sure exactly what does happen. It merely says that if we consider only the two sets of waves, we can account for what happens.

If we can account for what happens, and

our accounting method lets us predict what will happen in any normal set of circumstances, then it's a workable tool whether it's a correct one of not—and the concept of incident and reflected waves in a transmission line is just that, a workable tool. We don't need to know more than that in order to make use of it, any more than we need to know the atomic structure of steel in order to cut a hole through metal with a cold chisel.

Terman says the same thing in a different way on page 84 of his "Electronic and Radio Engineering" (fourth edition): "The voltage and current existing on a transmission line as given by equations 4-6 can be conveniently expressed as the sum of the voltages and currents of two waves." Notice that his sole reason for doing so was *convenience.*

Now that we've established the incident and reflected waves on a transmission line as convenient tools—without going any deeper into whether they actually exist as such—let's see how we must define each of them in order to make it into a useful tool.

The incident wave starts at the source and goes toward the load. It is the wave we considered in **Fig. 1**, in which both the voltage and current get smaller as we go farther from the source. Since the wave takes a definite time to go any given distance down the line, the instantaneous phase at any point along the line must lag as we get farther from the source. That is, the part of the wave most distant from the source must represent a part which left the source *before* any nearer part did.

There's nothing in the transmission line itself to alter the relationship between voltage and current in the incident wave, because the retarding effects of the distributed inductance along the line are cancelled by the advancing effects of the distributed capacitance and the net reactance is zero. Therefore the voltage and current at any point in the incident wave have the same phase relationship to each other that they had at the source.

All this means that we can describe the incident wave as a voltage accompanied by a current that is everywhere in phase with, and proportional to, the voltage. Because of the continual decrease of both voltage and current we saw in **Fig. 1**, both the voltage and current decrease as we go away from the source, and drop back uniformly in phase.

This description corresponds to that of a travelling wave, propagating away from a

source, and so we say that the incident wave travels *toward* the load.

The reflected wave, on the other hand, is identical with the incident wave except that it is travelling in the opposite direction. This means that it is largest at the load and gets smaller as it nears the source; its current goes toward the source rather than away from it, and its phase advances rather than dropping back.

The reflected wave comes into existence because of a reflection at the load end of the transmission line. Keeping in mind that the whole idea of incident and reflected waves is a *tool* based on a mathematical accounting for events, and not necessarily an accurate description of the events themselves, it's not too surprising to find that the generation of the reflected wave is dictated by equations in the mathematical accounting. Five separate sets of equations must be satisfied simultaneously to make the reflected wave account for events; we'll ignore the separate sets of equations and examine only their merged result:

The final result of the simultaneous solution determines a factor known as the "reflection coefficient", which boils down to be the ratio of voltage in the incident wave at the point of reflection to voltage in the reflected wave at the reflection point. If voltage in both is zero, as in the case of a short-circuit (which we shall examine before long) then the current ratio may be used instead—and since impedance is a quantity determined by voltage and current, it's possible to define reflection coefficent in terms of the ratio between impedance of the line and impedance of the load.

In a perfect line—one which has no losses and thus no attenuation—the reflection coefficient is the same anywhere on the line,

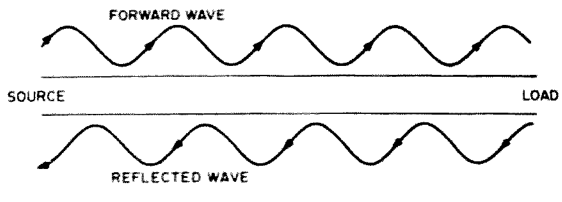

Fig. 2. Actual wave upon transmission line can be accounted for by two special waves called "forward" and "reflected" waves, each traveling in a single direction as shown here. Actual wave is then the net total of forward and reflected, at any point. Perfectly matched line has no reflected wave and forward wave is equal to actual wave; mismatch puts in "reflection" and modifies this situation. See text for details.

and is determined by that at the load. Any actual line, however, has attenuation; this attenuation acts oppositely upon forward and reflected waves because they go in opposite directions. Looking back at the source from the load, the forward wave gets larger as the source is approached because it has been affected less by attenuation, while the reflected wave gets smaller because attenuation is affecting it more. This means that on such a line, reflection coefficient is highest at the load or reflecting point, and becomes ever smaller as you move back toward the source. We'll see some practical implications of this fact, in the next section.

For now, though, let's back up a bit and look again at the relationship between the incident and reflected waves, and the actual voltage and current existing upon the line. It's actually very simple: the actual voltage at any point upon the line is the sum of the incident-wave voltage at that point and the reflected-wave voltage at the same point, and similarly the actual current at any point is the sum of incident and reflected currents at that point. If the two voltages (incident and reflected) are equal in value but opposite in sign, the "sum" would of course be zero since the two would cancel out.

Since the line is carrying ac, the voltage (at any one instant) is differenct at different points along the line both in value and in polarity. When we want to examine the situation all along the line rather than just at a single point, we speak instead of the voltage (or current) "distribution" on the line.

To see the part played by the incident and reflected waves in determining voltage (or current) distribution on a line, let's look at several examples of extreme cases. In all these examples we'll assume a perfect line with no losses just to simplify the situation. A little later we'll include the effects of losses upon similar examples.

For our first extreme, let's look at an open-circuited line which simply stops with no load of any sort connected to it.

With no place for any current to go, the current flow at the load end of this line must be zero.

But by our definition of incident and reflected waves, to account for this situation we must assume that both the incident and reflected waves do have current flow in them, of equal value but opposing sign. This is the only way in which the incident and reflected waves can cancel each other out to

produce an *actual* current of zero.

In other words, the open circuit reflects all the current which reaches it back down the line, reversing its polarity as it does so.

Our definition of reflection coefficient—the ratio of incident voltage or current to reflected voltage or current— tells us now that the reflection coefficient of an open circuit must be 1.0.

We can measure a voltage across this open circuit, which shows us that the voltage polarities at this reflection must remain unchanged although the current polarity reverses (had the voltage polarity as well been reversed, the measured voltage would have been zero).

At this point we have defined a reflection coefficient of 1.0 for an open-circuited transmission line. Let's move back along the line from the open circuit and see what happens to the actual voltage and current distributions.

At a point exactly ¼ wavelength from the open circuit, we are examining a part of the incident wave which is 90 degrees earlier in phase than that at the open circuit. The voltage of the reflected wave is 90 degrees *later* in phase than that at the open circuit, which means that from where we now stand the voltages of the incident and reflected waves are 180 degrees out of phase with each other. That's 90 degrees early for the incident combined with 90 degrees late for the reflected.

But in any ac waveform, any two points 180 degrees apart in phase have equal value and opposite sign. That means that, at this point, the voltages of the incident and reflected waves must always cancel each other out and the actual voltage at this point must always be zero.

How about current here? The reflection introduced a 180 degree phase shift in the current at the open circuit. The current of the incident wave is 90 degrees earlier than that, and that of the reflected wave 90 degrees later, so the currents of the incident and reflected waves are 90+180+90 or 360 degrees out of phase right here. But a 360 degree phase shift amounts to no shift at all in a periodic waveform—so at this point the current is maximum while the voltage is minimum.

Let's more another ¼ wavelength back so that we're examining a point a half wavelength back from the open. Now our voltage phase shift is 180+180 degrees, which amounts to no change at all, and we

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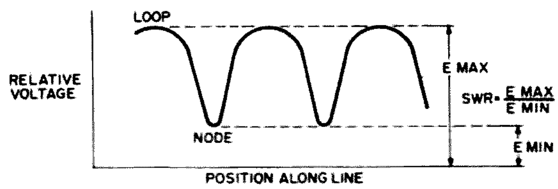

Fig. 3. Voltage distribution on transmission line having measurable standing wave ratio looks like this, if measured at various points along the line. Maximum-voltage points repeat every half-wavelength along line, as do minimum points. Ratio of maximum voltage to minimum voltage is one meaning of SWR; other meanings are equally valid as discussed in text. Note that voltage distribution does not follow a sine-wave pattern.

will find the same actual voltage as that which exists across the open circuit. The current phase shift is 180+180+180 or 540 degrees, which corresponds to a 180 degree change. The incident and reflected currents cancel each other out. Once again we find the same condition that existed at the open circuit.

As we move back on the line, at every ¼-wave interval we will find these conditions alternating. Every half-wave the conditions of the open circuit–full voltage with zero current–are duplicated, and at the intermediate ¼-wave points (usually called "odd quarter-wave" points) the opposite condition–zero voltage with maximum current–exists. It's brought about entirely by the phase relationship between incident and reflected waves, which is determined in part by the reflection coefficient at the open circuit and in part by the distance from our measuring point to the open.

Let's try another example. Instead of an open circuit, let's short the line out.

This gives us zero voltage across the short, together with maximum current. Curiously enough, that's the same condition we found at a distance of ¼ wave in from an open circuit.

To get the zero voltage, we must have again a reflection coefficient of 1.0 at the short, with 180 degrees phase shift for voltage and 0 degrees phase shift for currents at the reflecting point. That's the only way we can make the incident and reflected waves come out to match the measurable conditions at the short.

If we now move back a quarter wavelength on the line, we'll find a voltage phase difference between incident and reflected waves of 90+180+90 degrees, which amounts to no shift at all, and a current phase difference of 90+0+90 degrees, or 180 degrees, which produces cancellation. Full voltage and no current! The open-circuit condition, no less.

Regardless of our termination, we find that the terminating condition is repeated at half-wave intervals back from the load end of the line, and that its "opposite" occurs at the intervening ¼-wave points.

Let's look in a little more detail at that "opposite". When we terminated in an open circuit, which featured high impedance and almost no current flow, at the quarter-wave point we apparently had a short circuit, with low impedance and maximum current flow. When we terminated in a short, or low impedance, we found at the ¼-wave point an apparent open, or high impedance. We found, in effect, that a ¼-wave length of transmission line acts as a *transformer* to change high impedances to low, and vice versa.

Before we explore this idea any deeper, let's take one more example. What happens if we terminate a transmission line in another, identical, infinitely long transmission line?

Reflection coefficient, you'll remember, we defined as the ratio of incident to reflected voltage–and we added that it could be described in terms of the ratio of impedances also. If the two impedances are identical, the reflection coefficient must be zero. And if it is zero, then the reflected wave cannot exist; the actual voltage on the line and the incident wave must be equal to each other. In such a case, the line is said to be "matched." As it happens, we could substitute a resistor in place of any part of the infinitely long line, and if the impedance remained identical, nothing would change. This is the principle behind efforts to "match" antennas–and the success of our efforts to match impedances is measured in terms of a standing wave ratio or SWR.

We'll get into SWR in detail just a little later, after cleaning up a few loose ends about the major characteristics of a transmission line. We have determined that a line has capacitance, inductance, resistance, impedance, and attenuation, and that the energy in it at any point can be accounted for by incident and reflected waves travelling in opposite directions along the line. We have also determinded that any change of impedance along the line will cause a reflection, and that the amount of reflection is indicated by the reflection coefficient,

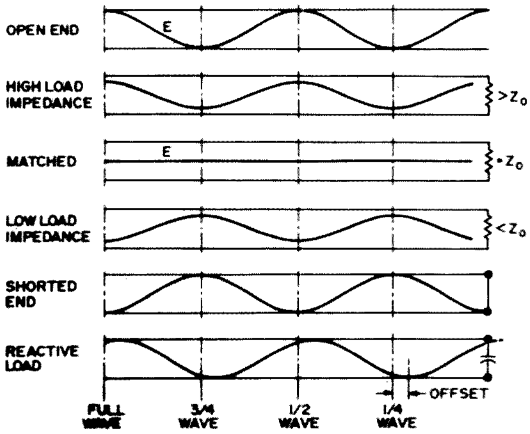

Fig. 4. SWR voltage patterns, similar to that shown in Fig. 3, for a number of different types of line terminations. Note range and phasing from open circuit (top) through matched condition (third from top) to short circuit (next to bottom). Effect of reactive loads is similar to open or short, with reflection coefficient of 1.0 for pure reactive loads; capacitance makes line appear longer and inductance shorter than physical length. Mixture of reactance and resistance changes phase (like reactance) and SWR (like lines 2 and 4) both.

which in turn is determined by the impedance ratio present at the reflection point.

We found that a reflection coefficient of 1.0 exists with either a short circuit or an open circuit as the load on the line, and that in either case the load condition repeated itself every half-wave back from the load, while the opposite condition occurred at the intermediate quarter-wave intervals.

But our examination of what happens when incident and reflected waves get together examined only a few extreme cases, and completely neglected the effects of line losses (attenuation). Let's see what happens when we plug the losses in too, and check out some in-between cases.

Remember that we found a complete cancellation between incident and reflected waves at the intermediate points, in our examples. This could not happen with any losses at all in the line, because the energy making up the reflected wave must always go farther along the line—out to the reflection point and back—than does the incident wave. The result is an almost, but not quite, complete cancellation instead—which leaves us a very small voltage or current in the incident direction, instead of zero. This is the only effect of small to moderate values of attenuation.

If we terminate a line in an impedance

greater than its own, but smaller than an open circuit—just to get a figure. let's say one three times as large as the line impedance—the result will be similar to that when we have an open, but not as extreme. The reflection coefficient in this case would be ½ instead of 1, which would make the reflected wave half as strong as the incident wave. When a cancellation would occur with an open circuit, only half of the incident wave would be cancelled in this case and the other half would remain. When a reinforcement would occur, the resulting sum would be a full-strength incident wave and a half-strength reflected wave, or 1-½ times the "matched" value. Both voltage and current would vary from half normal to 1-½ times normal, for a 3-to-1 variation.

At the quarter-wave point, the current would be 1-½ times normal and the voltage would be only half normal. This higher-current/lower-voltage condition defines an impedance LOWER than that of the line although the load impedance in this case is greater. We would expect this because we have already seen that a quarter-wave line transforms an open circuit into a short. The value of this lower impedance, though, bears the same ratio to the line impedance as the line impedance does to the load; in each case it's 3 to 1. That's necessary in order to keep the reflection coefficient constant all along the line. We can step up as well as down this way, and it's widely used.

What is a Standing Wave Ratio? We have just seen how any reflection upon a transmission line produces an interaction between the incident and reflected waves to create a pattern of high and low voltage points (loops and nodes) from that reflection back to the generator, and that this pattern does not vary with the instantaneous voltage or current of the outgoing energy.

Such a stationary pattern of voltage or current distribution is called a "standing wave" since it is not travelling. The amount of standing wave present on any line is measured by the "Standing Wave Ratio" or SWR, which is the ratio of maximum voltage to minimum voltage along the line, or alternatively the ratio of maximum to minimum current. This is very similar to the definition of reflection coefficient, and in fact SWR and reflection coefficient are related so closely that either can be converted to the other by a little arithmetic. The major difference is that reflection coefficient compares values in the forward wave with those in the reflected wave, while SWR compares actual maximum value on the line with actual minimum value and is thus somewhat easier to measure directly. Reflection coefficient, however, is easier to measure indirectly, and most of our "SWR meters" actually measure reflection coefficient instead, making the conversion to SWR by their scale calibration.

Some authorities speak of the "voltage SWR" or VSWR when they mean the ratio we have just defined, and use the bare term SWR to mean "power SWR". Power SWR is the square of voltage SWR, since the power in any resistor is proportional to the square of the voltage (or the current) applied to that resistor.

Fig. 3 shows a waveform view of what we've been talking about for so long, now that we have most of the words. While the illustration is based upon voltage waveforms, the same sort of thing is true of current waveforms as we saw a while back. Fig. 4 compares voltage and current waveforms in the SWR patterns created by several types of loads on the same type of line.

We saw last month that the presence of a standing wave upon an antenna structure made it easier for radiation to occur, and that also holds true of transmission lines. A high SWR will increase the likelihood of radiation from the line—which is usually an unwanted situation, since radiation is one major source of line losses.

A high SWR will also increase both leakage and resistive losses within the line, since it will increase current at the high-current points along the line ("current losses") and will increase voltage at the high-voltage points as well. Higher current means more power loss in a given resistance ($P=I^2R$), and higher voltage also means more power loss.

Most operators who take pride in a "good" operation, for these reasons, strive to achieve the lowest possible SWR in their transmission lines.

As we have indicated, SWR can be measured by actually measuring either voltage or current all along the line and then determining the maximum-to-minimum ratio, or by measuring the reflection coefficient with a "reflectometer" or "directional coupler" and converting to SWR. It can also be calculated by a much simpler rule: If the load impedance is known, and is a pure resistance without reactance, then the VSWR is equal to the ratio of load

impedance to line impedance (or line impedance to load impedance, whichever yields the highest figure). Our 3-to-1 example a few paragraphs back shows this, and how it comes about.

The VSWR, incidentally, can never be better than 1-to-1, since this says that the load and line have identical impedances and under this condition the line is perfectly matched. An SWR figure less than 1.0 simply says that you have a pretty bad SWR and have calculated it the wrong way; divide 1 by the figure you have to get the real SWR.

The VSWR of an open or a short circuit is infinite—but you can never measure it to be such a high value, because of line losses. The more loss in the line, the more the reflected wave will be reduced. The more the reflected wave is reduced, the less effect it can have upon actual net voltage or current an any point, and the smaller effect will produce a lower SWR. A long, lossy line is one of the best dummy loads available, because it can present a near-perfect SWR at its input end even when the load end is open circuited. For the same reason, SWR measurements should be made as close to the load end of the line as possible to escape this "swamping-out" effect of line losses.

Let's take as an example to calculate most of the things about SWR which the FCC wants you to know the case of a 52-ohm line terminated in a 104-ohm resistive load. We know immediately that the VSWR is 104/52, or 2 to 1. We also know that if 10 amperes are flowing in the antenna terminals, either twice as much or half as much will be flowing at a point ¼ wave back from the load because the VSWR is 2 to 1. Since the antenna's impedance is higher than that of the line, the ¼-wave point will have an impedance lower because of the transformer action—and in a lower impedance, more current must flow. This tells us that twice as much current will be flowing, and also that the point ¼ wave back is a current loop. Therefore 20 amps will be flowing at the loops, and 10 amps at the nodes.

Had the load resistance been less than that of the line but with the same VSWR (which would have required a 26-ohm load), the current at the ¼-wave point would have been only half that at the load. This would mean, in turn, that the load represented the highest current point or loop, and the other loops would have been at the ½-wave intervals back along the line.

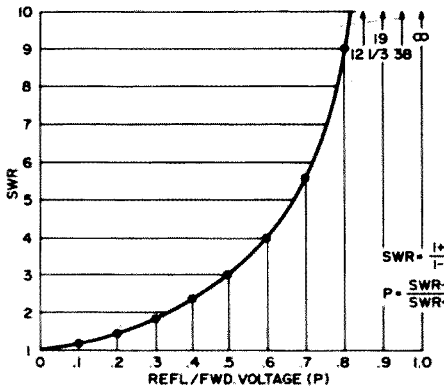

Fig. 5. Conversion from reflection coefficient to SWR and vice versa can be done by either this graph or the two equations shown here. Common SWR bridges and directional couplers measure reflection coefficient; any meter which is set to full scale with "forward" voltage or power and then read using "reverse" or "reflected" quantities probably works the same. Any meter movement can be calibrated for use with such devices by using horizontal scale here and taking SWR reading from vertical scale.

Getting the conversion from VSWR to reflection coefficient is fairly simple arithmetic. Fig. 5 shows the formula, together with a graph which permits reasonably close reading of the values (the formula is exact). With an SWR of 2, the formula tells us that reflection coefficient is (2-1) / (2+1), or 1/3. For every ampere or volt going up the line, 1/3 amp or volt comes back. But since actual energy is only that part of incident versus reflected which does not cancel out, it's quite possible to have 26-2/3 amps going up, 6-2/3 coming back, and find only 20 amps in the line! Either a forward power or a reflected power reading is meaningless alone so far as telling you what the actual power in the line may be; you must have both, and the actual power is the difference.

Just as VSWR is determined by voltage, and must be squared to get an SWR figure relating power, so is the reflection coefficient determined by voltage, and it too may be converted to a power figure by squaring it. This means that our VSWR of 2, produced by a 2-to-1 load-to-line impendance ratio, is a power SWR of 4, a reflection coefficient of 1/3, and represents a power reflection coefficient of 1/9. To get an actual power of 100 watts out, we must send 111.1 watts forward up the line because 11.1 watts (1/9 of 100) will be reflected back. Actually, it's a little more complex than that because the reflected power will be 1/9 of our forward power; this means that we must send more than 111.1 watts up. It works out to be 112.5 watts forward; 1/9 of this or 12.5 watts is reflected, and the remaining 100 watts is the actual power in the line. The percentage of reflected power is sometimes taken as the ratio reflected-to-forward times 100, and sometimes as reflected-to-total times 100. In the first case, the percentage of reflected power would be 11.1 percent (which is our original 1/9 figure); in the second it would be 12.5 (which is 1/8, and can be gotten by merely subtracting 1 from the denominator of our original figure). In practice, VSWR is met so much more often than is percentage of reflected power that you're not likely to have much trouble.

We've said that a high SWR was normally to be avoided. While this is true in transmission lines used to carry *rf* for considerable distances, there are exceptions. A quarter-wave section used as a transformer, for instance, must have upon it an SWR equivalent to the transformation ratio it is providing. If such a section is being used as a resonant circuit rather than as a transformer (that is, with one end open-circuited to produce the effect of a series-resonant circuit at the other end, or short-circuited to produce the effect of a parallel resonant circuit at the other) the SWR will be extremely high. While "infinite" is a bit too strong a term to apply to the SWR in such a case, it will be in the thousands or higher. VHF addicts who are familiar with the high currents to be found in coaxial or parallel-line tank circuits can attest to this fact.

In addition to the effects the SWR has upon line losses, the interaction between the forward and reflected waves modifies the line's input impedance. A 50-ohm line will only look like 50 ohms at the input end if it is matched to a 50–ohm load. If the load is 100 ohms instead, then the input impedance may be as low as 25 ohms resistive (for an odd number of quarter-waves of line length) or as high as 100 ohms resistive (for multiples of half-waves of line length).

But in between these extremes, even if the load itself is a pure resistance, the line won't look like pure resistance at all. Instead, it will show both reactance and resistance. Fig. 6 shows how the impedance varies along such a line with a VSWR of 2 to 1.

This fact helps explain why the pi-network transmitter output circuit, with its reputed ability to "match almost anything",

sometimes comes a cropper for no apparent reason. If the line length from transmitter to antenna just happens to fall in a region which emphasizes reactance, and with even a moderate SWR, the input impedance can become so reactive that no physical component in the pi-net can possibly provide proper adjustment. For instance, while loading is usually minimum with the output capacitor set for maximum capacitance, a pi-net in such an unhappy circumstance as we are examining here may already have far too little capacitance even when the capacitor is set at maximum. With critical line lengths and SWR as low as 2 to 1, it's possible to run into a need for *negative* capacitance (not inductance, which has opposite reactance sign but behaves differently with respect to frequency!). quency!).

It's also possible, at a critical line length on the other side of resistive point, to find that even with the loading capacitor set to minimum the circuit just won't load. This is because most of the capacitance of the circuit is being supplied by the line's input impedance.

In both cases two cures are available; one is to reduce the SWR, and this is the one usually recommended by most authorities. It's fine for a commercial, single-frequency operation, but hams must operate over the limits of a band rather than on a spot frequency and SWR necessarily changes from one end of a band to the other. The other cure is simpler—just adjust the line length by adding a 1/8-wavelength extension to the line. The SWR remains the same, but the length is no longer critical and the transmitter can once more be loaded. It will seem to act normally, for a change.

How Are Operating Frequency and Antenna Design Related? Any wire antenna is a circuit with "distributed" constants. That is, its inductance, capacitance, resistance, etc., are distributed throughout its length rather than being lumped into concentrated areas. Because of this, the current distribution in the antenna which results from applying a voltage at just one location depends upon, among other things, the length of the wire—which is measured in wavelengths. This is one of the most fundamental relations between operating frequency and antenna design, because operating frequency and wavelength are simply two ways of measuring the same property.

Last month we made the acquaintance of both "resonant" and non-resonant or "travelling wave" antennas. In both cases, the directional pattern of radiation was determined by the current distribution upon the antenna in conjunction with the relative phasing of the radiated fields from each tiny part of the antenna structure—and phasing also is related at least indirectly to operating frequency, because the frequency is a measure of the time between points of identical voltage in the signal, and phasing is a measure of the same quantity but in a different context. Frequency is measured in terms of the time to reach an identical voltage at the same point is space, while phasing is measured in terms of the time difference between points of identical voltage at different points in space.

Last month we concentrated largely upon the action of the non-resonant amtenna; this time let's turn our gaze to the resonant case.

A resonant wire corresponds to a transmission line that is an exact number of half wavelengths long and is open-circuited at both ends (a non-resonant antenna also corresponds to a transmission line but it is matched at both ends). We have already seen that such a transmission line will repeat the conditions at its end every half-wave along its length. If the wire is only a half-wave long, it will repeat the open-circuit of one end precisely at the open circuit which is the other end. If it is a full-wave long, again the open from one end will repeat at the other, but now both the opens will repeat at the midpoint of the wire as well.

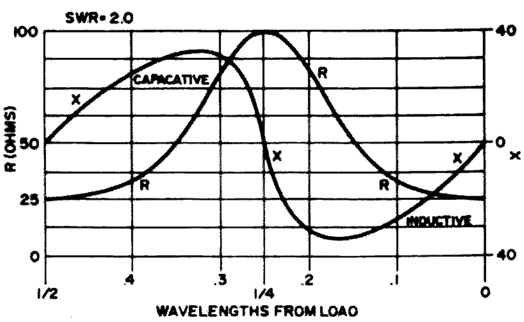

Fig. 6. Variations in both resistance and reactance along transmission line with SWR of 2.0 over any half-wave interval are shown here. Source of line is at left, and load is toward right. At 0 and ½ wavelength points, resistance is lowest and reactance is zero. At ¼ wavelength points, resistance is highest but reactance is also zero here. All other points have intermediate resistance, but also reactance. Patterns are similar for other values of SWR but variations are more extreme when SWR is higher. With extremely high SWR, resistance approaches infinite values.

A half-wave length of wire is two quarter-wave lengths back to back. But a quarter-wave length of transmission line open-circuited at one end will appear to be a short circuit at the other end. This would indicate that a half-wave length of wire open at each end should have an apparent short circuit at its midpoint—and except for the fact that the wire does have some "losses" (the radiated energy is lost so far as the standing wave upon the wire is concerned), it well might! The impedance is very low at the midpoint, at any rate. This low impedance provides a feedpoint for the antenna which matches a low-impedance feedline, and is known as a "current-fed" system.

The low-impedance points produced by quarter-wave transformation of the open circuits at the antenna ends will coincide only when the operating frequency is such as to make the antenna an exact half-wave long, electrically. If operating frequency departs even slightly from this one single spot, the two low-impedance points will not coincide, although the impedance at the center will still be low over an appreciable band of frequencies.

As we saw in Fig. 6, when even a moderate SWR exists upon a transmission line the impedance is pure resistance only at exact quarter-wave intervals along the line. At all other points reactance is present also. An antenna, being a pair of quarter-wave transformers, operates with a very high SWR upon its structure, and the variations shown in Fig. 6, are exaggerated still more in this case. This means that if operating frequency is not precisely that for which the antenna was cut, the antenna cannot be a pure resistance to its feedline. Again, reactance will remain low ever an appreciable spread of frequency. Bandwidth depends upon the particular antenna design; some have wider usable bands than others.

Outside this usable band of feedpoint impedances, the mismatch between antenna and feedline is so great that more power is reflected than is radiated. We say that the antenna in such a situation "refuses to load."*

For any single length of wire fed at its midpoint, there is a single lowest frequency

*(*Ed. note: A purist will quarrel with this terminology. An antenna does not "load." It presents a load to the transmitter. The transmitter will refuse to load into a mismatch. The antenna will refuse to radiate.)*

at which it can operate in this manner; that's the frequency at which the wire is electrically one half-wave long. If operation at twice this frequency is attempted, then each side of the antenna acts as a half-wave repeater rather than a quarter-wave transformer and it will refuse to load.

As we go up in frequency to three times the original value, though, we reach a point at which each half is three quarter-waves long, and the wire again acts as a pair of transformers. The loading conditions of the first frequency are essentially repeated here, and the antenna radiates nicely.

At four times the original frequency, we have repeaters again instead of transformers. In fact, at any even harmonic of the first or "design" frequency the halves will act as repeaters and a minimum of energy will be accepted. However, at any odd harmonic of the design frequency the halves will act as transformers and operation will be similar to that at the design frequency. The radiation pattern will, of course, be different at each frequency because of phasing interaction—but the antenna will accept and radiate the energy from the feedline.

The antenna we've been examining is, of course, the familiar half-wave dipole which appears in many variations such as the folded dipole, the inverted vee, etc. The same principles apply to all; at the design frequency and odd harmonics operation is excellent, and at even harmonics essentially no energy is accepted or radiated. Such an antenna is said to reject even-harmonics. If cut for operation at 7 MHz, it can also be used on 21 MHz.

Current feed is not the only possible way to feed an antenna. It could be fed at a high voltage point instead, with a transmission line of sufficiently high impedance. This would change things, since the high voltage point is at one end of the line. At the second harmonic, now, the line is a full wave long—and the antenna is still matched. At the third, the length is one and a half waves, and the matched condition persists. An end-fed half-wave, then, will accept all harmonics either—odd or even. Often called a "Zepp" antenna (such antennas were used on early Zeppelin airships), this type of antenna is popular with operators who like to use all bands and have only limited space in which to erect antennas.

Similar operation can be achieved with current feed by connecting several antennas in parallel and feeding them all at once from

the same line. Each antenna is cut for a different frequency. Those which are offering high impedances take little energy and so have little effect, while those which offer low impedance take most of the power and do most of the radiating. In such a case, the composite antenna will exhibit at least some SWR at all frequencies, because the "idling" antennas will put some reactance into the line, but operation is highly satisfactory. The major disadvantage—as for any all-band antenna—is that harmonics are radiated as well as is the fundamental frequency, if they should happen to reach the antenna in the first place.

Directive antennas achieve their effects by intricate phase relationships which we examined last time around. These are all frequency-sensitive, and most types of directive antennas are even more sensitive to operating frequency than is the simple dipole. The traveling-wave and reflective antennas are exceptions, since their effects are achieved differently.

In fact, the non-resonant traveling-wave antenna is almost independent of operating frequency, although its directional pattern changes slightly with changes in frequency. Such antennas, then, radiate harmonics as well as fundamentals, but can be used over frequency ranges as great as 2-to-1 or more without adjustment.

While our example so far has been the half-wave center-fed dipole, all that we have found applies equally well to a quarter-wave wire or whip mounted vertically upon a reflecting ground plane. The reflection from the ground plane acts as the missing half of the structure. Such antennas are used throughout the HF and VHF range, for both home and mobile stations.

What Are The Most Popular Types of Antennas in Ham Use? The number of different types of antennas is almost limitless, because virtually any structure which is capable of reflecting or refracting a radio wave and which can be coupled to a feedline of any sort *can* be used as an antenna. used as an antenna.

However, only a relatively few types have any major popularity. Preferences differ depending upon the frequency range of interest: the UHF addict for instance will almost never be found using a simple dipole, while the 40-meter enthusiast seldom sports a quad Yagi array.

The two major categories into which antennas can be divided when discussing popularity are "non-directive" and "directional". The major difference, in most cases, is that the directional antenna is usually set up so that it can be pointed in the desired direction, while the non-directive antenna is installed in a fixed location.

But at low frequencies, and in some other special cases, directional antennas may be permanently mounted in a single direction, and any "steering" that is to be done is accomplished by switching to another antenna rather than by moving the single structure.

Most hams operate primarily in the HF range from 3 to 30 MHz; those who use the three lower-frequency bands frequently stick to non-directive antennas, while those who operate primarily at 14 MHz and higher use some type of movable directional antenna.

VHF and UHF enthusiasts, almost without exception, perfer movable directional antennas. Occasionally they will use a non-directive antenna as a "backup" installation for local rag-chews.

The non-directive antenna classification includes three major types, each of which has many variations—each with its own name. The major types are the long-wire, the resonant horizontal, and the vertical.

The long wire, as its name implies, is a random length of wire. It is exceptionally popular among beginners because of its ease of installation. As experience with antennas is gained by the operator, the long wire is usually replaced by some other type which is easier to live with. A long wire's directive pattern is unpredictable, and it may or may not accept *rf* energy properly at any specific frequency. It offers little or no reduction of harmonic radiation—but the accompanying antenna tuner which frequently is necessary in order to get the antenna to accept *rf* energy does help reduce harmonics.

The most popular example of the resonant horizontal antenna is the half-wave dipole—which is possibly *the* most popular ham antenna. This antenna tends to reject all even harmonics of a signal, but will radiate odd harmonics almost as well as it will the frequency of its fundamental resonance.

A group of half-wave dipoles all connected together at the feedpoint, and each cut for a different ham band, is known as a fan antenna. Each dipole acts individually. The harmonic-rejection capability of the single dipole is lost, but such an antenna will operate on all ham bands and so is popular with many operators.

A single dipole may be loaded with

lumped-constant traps so that it automatically adjusts its effective length to fit several fundamental frequencies. Such an antenna is called a "trap" antenna and is in wide use as an "all-band" antenna for operation on the bands from 3.5 through 30 MHz. Its harmonic-rejection capability depends upon the exact design of the traps and upon the particular frequency in use.

A dipole antenna fed at the end rather than in the center is known as a "Zepp" antenna and is moderately popular. This type of antenna will radiate all harmonics of its fundamental frequency, in contrast to the center-fed dipole.

An offset-feed resonant horizontal antenna which has enjoyed moderate popularity from time to time is known as the "Windom" antenna. When cut to appropriate dimensions and fed from the proper off-center position, it provides a resonable match to 300-ohm twinlead on all the HF ham bands and so permits all-band operation. The trap antenna has displaced the Windom for many operators since it offers the same type of operation but permits use of coaxial feedline. Like any all-band antenna, the Windom has little harmonic reduction inherent in its design.

The most common vertical antenna in the HF range is the Marconi or quarter-wave vertical, which is simply a center-fed dipole cut in two at the feedpoint. The missing portion is supplied by ground reflections. Such an antenna is often used for 80 or 40 meter operation.

The corresponding design for 20-meter or higher-frequency operation is the ground-plane antenna, in which a metallic structure of rods replaces the actual ground to provide the reflections. This is a popular antenna up through the 50 MHz band.

Either the half-wave dipole or the Marconi may be "folded" to increase its feedpoint impedance. The dipole gets the name "folded dipole" while the Marconi becomes a "folded monopole" antenna. The "folding" consists of connecting another wire to the open end or ends of the antenna. In the dipole, the added wire connects the two open ends; in the monopole, the added wire connects to ground or the ground plane at the lower end.

Both the fan and trap variants of the dipole may be found in vertical versions as well, and both are moderately popular.

Among directive or "beam" antennas, far and away the most popular is the parasitic Yagi design. It comes in single-band, multi-band, and trap versions. The single-band corresponds in characteristics to the plain dipole, the multi-band to the fan dipole, and the trap to the trap dipole. Since Yagi has many more critical dimensions than does a simple dipole, it is inherently less apt to radiate harmonics. If a multi-band or trap version is in use, however, and a harmonic happens to fall within a region which is one of the antenna's higher-band operating regions (as, for example, a 10-meter harmonic of a 20-meter signal), it will be radiated.

Running the Yagi a close second in popularity is the "quad" antenna, which is a parasitic array of loops rather than rods. It is found in both single-band and multi-band designs; actually, a multi-band quad consists of several single-band quads sharing the same supporting structure and a common feedline, and so somewhat corresponds to the fan dipole.

VHF and UHF operators also make wide use of colinear arrays, most of which are variations of the Franklin colinear antenna and include both endfire and broadside array principles.

UHF operators, in particular, are employing parabolic-reflector "dish" designs for advanced work, as well as helical-beam antennas. These, however, are "popular" only in this limited area of interest.

We're a long way from exhausting the list, but it's long enough to more than accomplish the purpose of answering FCC questions. If you're really fired up with interest, check the various books we recommended last month—they'll keep you so busy studying antennas that you'll have time for very little else, and even then you won't be keeping up with the state of the art because it's changing too rapidly!

Soft Solder Construction of Cavities and Lines

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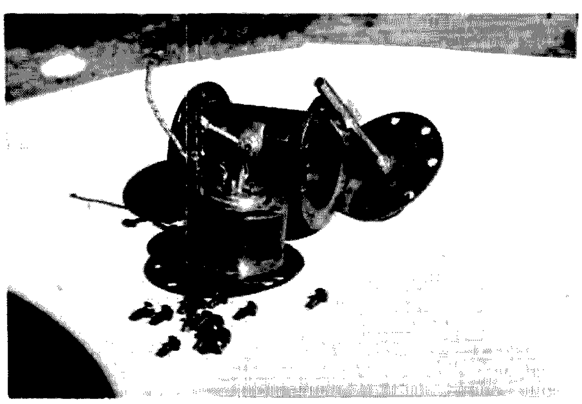
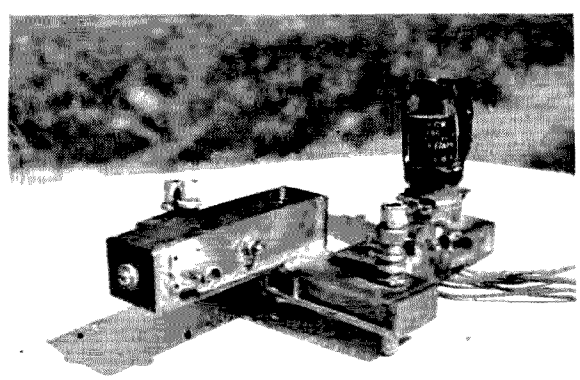
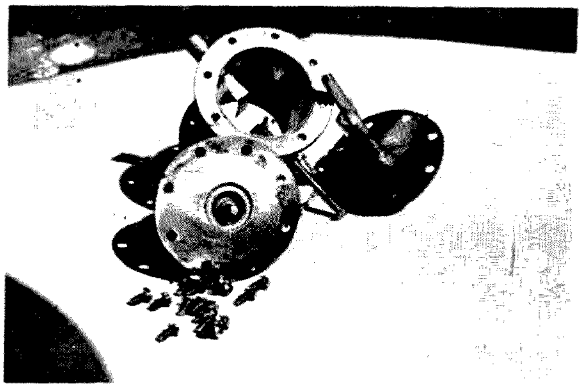
Most every piece of information on microwave equipment is either line drawings, or pictures showing very complex machined parts. It would be nice to have the proper skill and a machine shop. This isn't always practical however. Here then, is the next best construction method that any experimenter can use. Soft solder construction uses ordinary solder, either core or solid, and the only tools needed are simple hand tools found around any ham shack. So simple is the first method of construction described here, that line drawings can be followed almost exactly. I have repeatedly used this method. An oversized end plate, or what have you, is soldered to the line or cavity and then filed down to fit. Although a perfect fit is insured there are some disadvantages. A complex design cannot be built easily by this method, as any excess heat will cause all the parts to fall apart. The cathode cavity for the 416-B was constructed by this method. One secret for keeping things together is to start by soldering the larger and heavier pieces first, then progress to the smaller items. Along with this method, one of my favorite ways of construction uses ordinary copper or brass pipe with flanges made of large heavy washers. The large washer centers are laboriously filed out to the outside diameter of the pipe with a rat tailed file. Fortunately I found a friend to turn some out on a lathe. I used steel washers, but I would advise the use of brass if you can find a supply. After filing out the washers, the washers were then soldered to the pipe. Holes were then drilled and tapped. The ends are then draw filed to insure a good fit. The file is ordinarily used lengthwise but in draw filing, the file is held by each end. The file is then drawn over the material in a flat horizontal fashion. The ends could also be "lapped," using a good grade of emery cloth over a flat surface. The end plates were made of 1/16 inch stock. It's a good idea to mark the end plate and washer so they can be aligned, just in case the holes are not evenly spaced. The plate line for the 416-B uses this type of construction. This type of construction has several advantages: (1) material is cheap; (2) the line can be shortened easily; (3) easy access can be gained to the inner cavity; (4) can be used for any shape of line, round, square, etc. Lines or wave guides can be constructed of 1/16 inch or heavier flat stock by allowing enough extension to form a good solder bead. "C" clamps can be used to hold the sides in place. After soldering, the joints may be wiped. Wiping is a method whereby the solder is brought up to the melting point and wiped with a cloth. The purpose is to give a neat look and to remove the excess solder. If the solder is too cool the appearance will be rough. "Fanning" with the blaze of a torch until the solder is just about ready to flow will give a smooth surface. Oftentimes the cavity or line will become



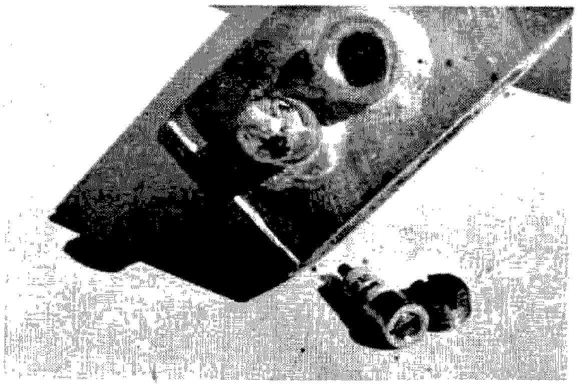
Soft solder construction.



Parametric amplifiers.



Using washers of steel or brass soldered to the pipe.



Crystal diode holder.

the support for other components. One component, the crystal diode, for instance, can be rather easily mounted. A suitable crystal diode holder can be constructed from a nut. The i.d. should clear the body of the crystal centered and soldered over a hole in the wall of the cavity or line. The hole is drilled to fit the main body of the diode crystal. A cap to hold the crystal in place is cut from a bolt with the same thread and size as the nut. The cap need only be approximately 3/16 inches long with a screwdriver slot cut at the top.

I usually use threaded BNC fittings. Soldering a threaded nut to the walls of a cavity or line presents a special problem. During the soldering process, the threads of the nut fill up with solder. The simple solution would be to use a 3/8 -32 tap to clean the nut, but trying to find a tap that size is a still bigger problem. In the meantime, I dirty up an old BNC or the threaded portion of an old pot, and use it to hold the nut in place and keep my fingers crossed that it doesn't get soldered. I suppose that I have about 50% luck. Tubes are often mounted within the cavities. The gold nugget, 416-B, is one such tube. Mechanically there are two problems in using this tube. One, the grid requires a threaded hole 3/4 inch 40 threads per inch and two, the cathode requires a mount. I had a machinist turn out some rings 1/8 inch thick with a 3/4 inch hole 40 threads per inch. I soldered these rings in place for the grid connection. As for the cathode mount, I used finger stock made from brass weather stripping. This is an excellent material for finger stock as it has lots of spring and is easy to cut and shape. One way of cutting the weather stripping is to sandwich it between two pieces of hard wood. Hold firmly in a vice or with "C" clamps. Use a hack saw to cut slowly, evenly spaced slots. The finger stock can then be shaped. Literally speaking, the next method is cooking in oil. This is a useful method used in soldering large parts where heat is not of consequence. This is the oil bath method. Oxidation becomes a big problem when parts are being heated and usually requires the use of flux. Flux does one of two things: one, it will etch away oxidation; or two, it will flow over the heated area and prevent oxidation. Larger parts require a lot of heat; thus, oxidation will occur, so an etching flux is necessary. In the oil-bath method, the parts to be soldered are assembled in a tray or shallow pan filled to a level sufficient to cover the area to be soldered with a high ignition point oil. The oil and parts are heated enough to cause the solder to flow freely. The oil acts as the flux in the fact that it keeps the air from the heated parts. Although the soldering is actually done in the oil, very good results are to be expected. A simple household detergent can be used to remove the oil and you will have very bright soldered parts. This method is also useful in salvaging parts from printed citcuit boards, or from "can" type structures in which parts are sometimes mounted. The XYL's cooking range can be used as a heat source. As a word of caution: safety precautions should be taken. It would not be unreasonable to use goggles and gloves. There is always a danger of reaching the ignition point, thus a fire. Keep a box of ordinary baking soda close at hand. In case of fire sprinkle the baking soda over the fire and avoid breathing the fumes. This is a trick the XYL has probably used many times when cooking. Here are a few ideas which I hope will dispel the notion that one cannot build cavities, lines, or wave guides without a machine shop.

...WA9VFG

Police Converter

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Besides having the fun of building this police converter and listening to the exciting calls, this circuit has other possibilities as shown in Fig. 2, as a 2-meter oscillator for your 2-meter converter (ugh on using a transistor oscillator into a diode harmonic generator as of old).

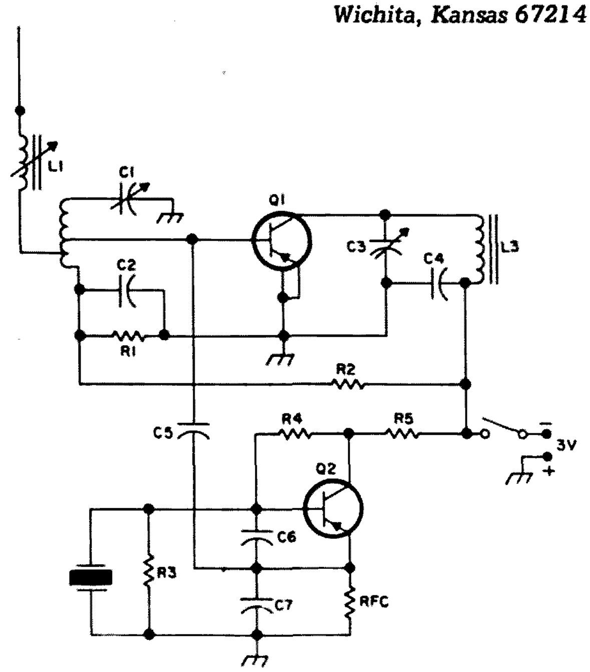
I also made up a one transistor oscillator using a 48.383 MHz. HC18/U third overtone xtal to see what kind of a signal it would put out on 2. On my bench, about 15 or 20 feet from my receiver, it put out almost as good a signal as my Millen grid dipper. There was also 48.383 signal present about ½ the strength of 145.15 MHz. I didn't try to trap it out. This will make a good signal source for 2M and with proper crystal, a cheap frequency standard for club or MARS frequency.

I also tried modulating it as a modulated oscillator (not on the air) it FM'd quite a bit, but could be read. I am sure that with a cheap final stage it would make a nice low-power transmitter for transmitter hunts on 2M, etc. A 2N1141 would work as a final here, but I can't say how much output you'd get.

A few of you may not of ever seen this oscillator circuit. It is Scotch for sure, using one transistor third overtone oscillator/tripler. What more do you want? I am sure there are others like me who lift part of a circuit from a magazine and use it.

I hope this will suggest many circuits to you. Another thought would be a small signal generator and a good hot check for third overtones (provided the output coil was tuned to the 1st, 2nd or 3rd frequency marked on the crystal. All overtone crystals (I think) are marked with overtone frequency. In other words, a 48 MHz crystal could put out 48 MHz (without a tuned circuit—if you wish), 96 MHz and 144 MHz. I haven't tried this oscillator to see if it will work higher harmonics of the crystal.

Getting back to the police converter; some commercial jobs use Japanese transistors and I used 10K in the base circuit of the mixer back to ground and I lost a 2N2996. I had to use a 2.2K. I mention this as a point to check carefully when you use different types of transistors.

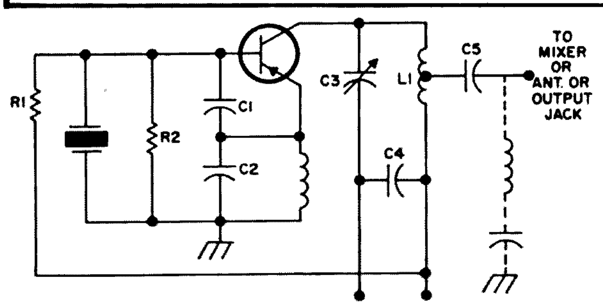


Parts List

C1 = 2-15 pf trimmer
C2 = .001 mfd.
C3 = 10-200 trimmer
C4 = .01 to .05 mfd (Iused .05)
C5 = 5 pf.
C6 and C7 = 33 pf.

L1 = 6T #24 on ¼" slug form
L2 = 4T #14 3/8" dia. ½" long tapped at cenfor base of Q1 and 3/4T from cold end for antenna.
RFC = aircore 17T #24 ¼" dia.
L3 + Loopstick ant. from junk transistor radio.
R1 = 2.2 k
R2 = 27 k
R3 = 10 k
R4 = 18 k
R5 = 15 to 27 ohms
Q1 = 2N2996 TI
Q2 = 2N1141 TI
xtal: see text.

The police frequency here is 155.15 (I understand this may be true over the USA, but I'm not sure—better check) and as in any superhet, the oscillator can be above or below the incoming signal. Crystal frequencies between 51.9 to 52.250 (being on the high side of the received signal) will permit the broadcast radio to tune to the converter and,



Parts List

R1 = 18 k
R2 = 10 k
CI = 27 pf
C2 = 27 pf
C3 = 1-12 pf trimmer
C4 = .01 mfd.
L1 = 3½T #14 3/8" dia. 5/16" long
L2 = 16T #24 aircore ¼" dia.

L3 and C6 can be a 48+ Mc. trap
Xtal = 48+ mc. (depends where you want on 2 M)
Q= 2N1141 TI

crystals between 51.183 to 51.533 (low side of signal) will also permit converter to work into a BC radio. Compute it thus:

155.15 MHz - .550 MHz (low end of BC band) = 154.6/3 = 51.533 MHz

155.15 MHz - 1.6 MHz (high end of BC band) = 153.55/3 = 51.183 MHz, which is the crystal frequency for each end of BC band.

155.15 MHz + .55 MHz = 155.7/3 = 51.9 MHz

155.15 MHz + 1.6 MHz = 156.76 3 = 52.25 MHz

Select any crystal frequency between these points, but be sure there isn't a local or a strong station picked up on your BC radio at this point or you will have a squeal or garbled output.

Three volts powers this nicely. If you use 9 volts, resistors will have to be changed and that means metering each transistor and checking oscillator output and checking the gain of the mixer.

This converter placed near (3 or 4 inches) or laid on a transistor radio so both loops are coupled somewhat is all that is needed.

A word to save some of you young 'uns some grief, if you get this idea! You select the proper crystal and this circuit to listen to a club frequency on two meters.

Happy listening to police or ham frequencies with this and may it furnish you with other project ideas to build. ...KØVQY

The Neglected Mini Vee Beam

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Many of the current crop of hams do not have even a nodding acquaintance with the Vee beam – yet it is an antenna with some very positive advantages: it will provide excellent gain on three or more bands; is easy to build and tune up for real efficiency over a wide range of frequencies; and it is so neat and inconspicuous that it will be a lot more popular with the neighbors than the usual quad or tri-bander.

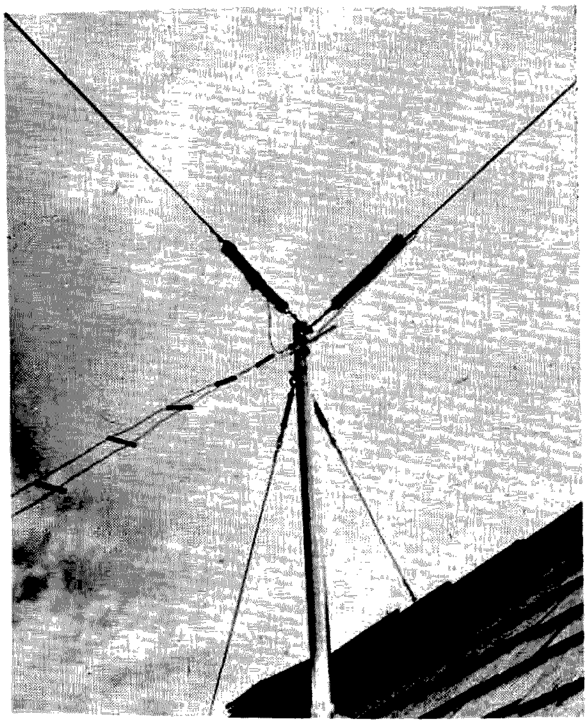
Probably one of the reasons that the Vee beam has been so neglected is that those hams who do know something about the configuration usually feel that the antenna is not practical unless you live in the country – or at least on an acre of ground.

Happily, this point of view is not quite true. Size does help, of course, but it is possible to build a Vee beam which provides very worthwhile gain on 20-15-10 meters, yet can be put up on the average city lot, particularly if you have an understanding neighbor who will allow you to run a small portion of it over one corner of his property.

And such an antenna does perform effectively. The one illustrated was first put on the air on 28 megacycles. In actual use, a flattering number of CQ's resulted in three and four station pile-ups on the frequency – from stations 1500 to 2500 miles away.

On 10 meters, of course, this is no great trick, ordinarily. But the transmitter used for test purposes was an ancient, modified Heathkit At-1, running about 40 watts input, *AM Phone*, and doubling in the final amplifier, which meant that there was something less than 20 watts in the antenna. Despite the low power, reports of "10 db over S-9" were commonplace, and one CQ was answered by a station in northern Japan.

The theoretical gain of a Vee beam of the dimensions shown is approximately 6 db on 10 meters, or about that of a typical 3 element beam. On 15 meters, gain is somewhat less, approximately 5 db, and the gain is in the neighborhood of 4 db on 20 meters. In the writer's opinion, though, and the opinion is shared by others, a long wire antenna of any type will deliver more in actual


Mini-Vee beam for 10, 15 & 20.

communication gain than a parasitic array which is rated at the same level.

This is *probably* true for at least two reasons. First, long wire antennas do not seem to require as much height, to deliver low angle radiation, as is needed for the smaller beams. Second, receiving "efficiency" – if there is such a thing – seems to be markedly better. At any rate, a Vee beam or other long wire type of antenna, will often dig out DX which other local stations are having difficulty receiving, and pull in that DX with less QSB. This could be accounted for by the fact that the long wires develop both vertical and horizontal polarization – and in addition, the larger capture area provides for a kind of diversity reception.

Perhaps *none* of these theories is entirely correct – but there is no question about the results; long wire antennas, particularly Vee beam and rhombics, have justly earned a reputation for generating outstanding signals.

A Practical Vee Beam

The drawing, Fig. 1, shows the layout of a Vee beam which is small enough to be practical for many hams. It is fed by a tuner, the circuit of which is shown in Fig. 2. Regular readers of "73" will recognize the tuner as being a modification of one described in a past issue by W5DWT. It is simpler than the W5DWT version because it is designed for only three bands. Despite its simplicity, the tuner will bring the antenna to exact resonance at any frequency in the three bands, and will provide a virtually perfect load for the transmitter, allowing standing wave ratios as low as 1.1 to 1, or beyond the accuracy of the usual swr meter.

The antenna is likewise very simple, consisting of two wires, mounted parallel with the ground, and as high as local conditions permit. The antenna shown in the photograph is approximately 25 feet above the ground, higher, of course, would be better.

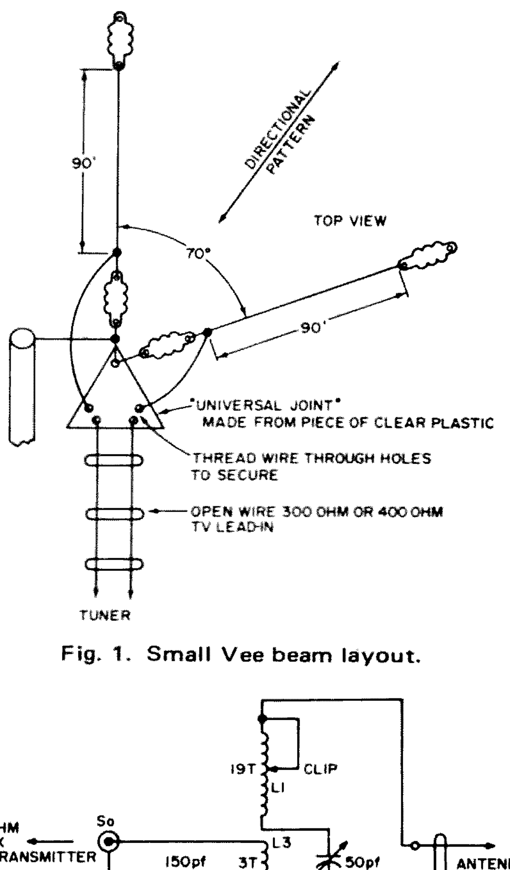


Fig. 1. Small Vee beam layout.

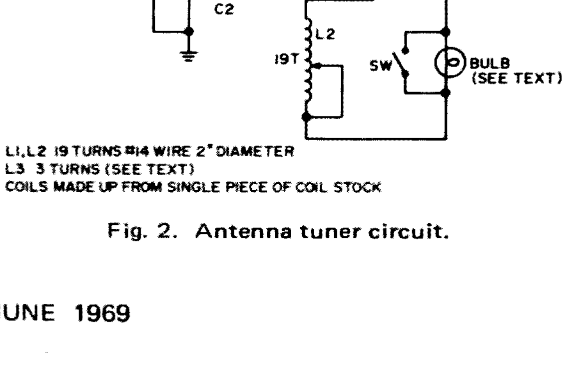


Fig. 2. Antenna tuner circuit.

Ideally, the feed line would drop down from the antenna at right angles, however in practical application this frequently is not possible. Both the photograph and **Fig. 1** show a kind of "universal joint" made up from a piece of clear plastic, which serves as the termination point for the feed line, and allows the feed line to leave the antenna at almost any convenient angle.

The feed line itself is the open wire "ladder" type of TV line, either 300 ohm or 450 ohm (preferably the latter). This line is adequate for any SSB rig which does not have a linear amplifier – or for a CW rig up to 200 or 300 watts. For powers above that, the line should be made up with number 14 wire, and either ceramic or clear spreaders.

Remember that even a 90 foot wire, loaded up with ice, can become pretty heavy, so if you live in W1 land be certain to use strong turnbuckles, screws, etc. The same thing applies for W4's, who on occasion experience what they call "atmospheric disturbances" that blow down palm trees.

The 70-degree angle is about optimum for an antenna to be used on three bands. However, if this angle isn't possible, you can narrow it to 50 degrees, or, preferably, use a larger angle, up to as much as 90 degrees. The last-named angle will reduce gain somewhat on 10 meters, but will give better results on 20 meters.

The Vee beam provides a "figure 8" bidirectional pattern. With the dimensions given, the pattern is quite broad.

Building the Tuner

The tuner for the Vee beam is made up on a 5 x 7 x 2 inch chassis. Building the tuner requires a minimum of parts: two tuning condensers, one length of coil stock, a switch, a dial light bulb, some insulators, and miscellaneous hardware.

The smaller of the two variable condensers, (50 pf.), should be double spaced. Since it is used at a low voltage point, even a midget variable like that shown is adequate for a fair amount of power. A single spaced variable condenser, 150 pf. or larger, likewise should do the job even for the more powerful SSB rigs run barefooted. If you go in for a gallon, use condensers with more spacing at both points.

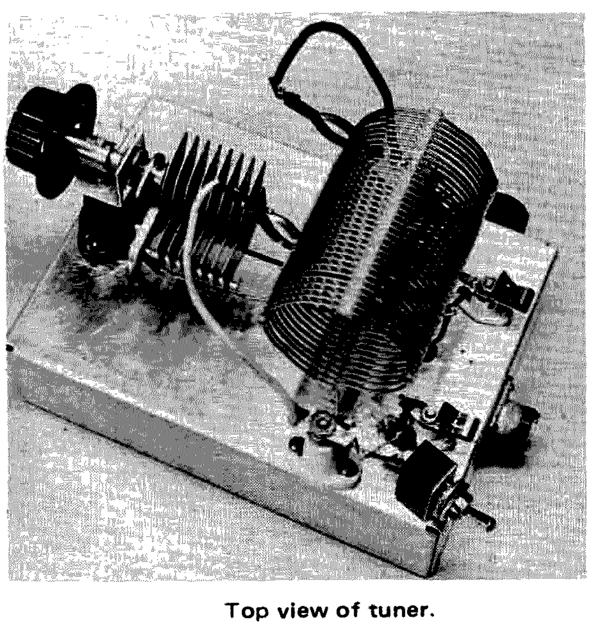
The coil can be of standard coil stock (B+W 3900). If you have difficulty in obtaining coil stock, you can roll your own, as detailed in the writer's book, "Ham Antenna Construction Projects," which is available from any Howard W. Sams' distributor.

Notice that the coil is actually *three* coils. This is accomplished by clipping the coil stock at the proper point with sidecutting pliers as shown in the photo. I found that clipping the coil is easy, but following the turns by eye to make certain which winding is which can be confusing. The best answer is to use an ohmmeter as a continuity meter – or a flashlight bulb and a battery. It sounds ridiculous, but the tuner illustrated failed to work properly, and it took me, a ham for over 30 years, all afternoon to discover that the connections to the clipped-apart-coil were wrong!

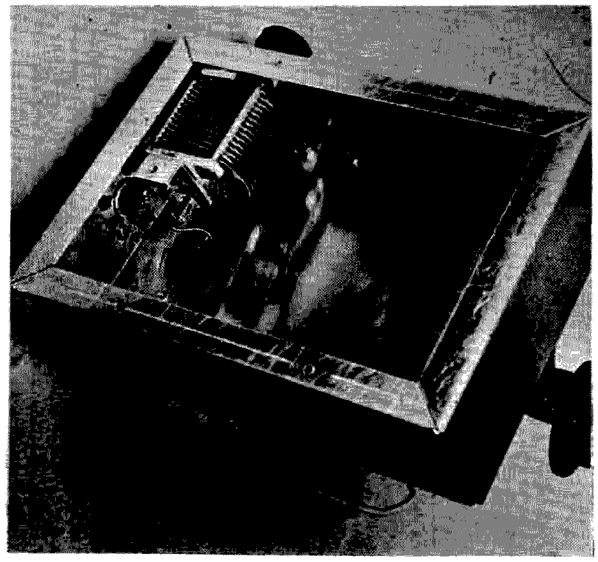
The tuner is so simple that the actual wiring is at most an hour's job – and if you are handy with a soldering iron, you can do it in half that time. Use some scrap lengths of No. 14 wire, if possible, for the leads. Note that the variable condenser above the chassis is mounted on an insulator so that both the rotor and stator are "above ground." The variable condenser below the chassis can be mounted directly to the chassis, since the rotor is grounded.

Tuning Up The Antenna

The Mini Vee beam, like any center fed antenna fed with a tuned line, can utilize a simple resonance indicator which shows when there is actually power in the antenna. And this is what counts – *not* the swr ratio. A low swr is a fine idea, especially with an antenna fed directly with co-ax, but contrary to what appears to be an unfortunate popular opinion, a low swr reading *may* mean simply that you have lucked into a critical length for the coax you are using. Low swr does *not* guarantee your antenna is working efficiently – a brutal fact explained in an earlier "73."



Top view of tuner.



Bottom view of the tuner.

With a tuner like that shown you have the best of both worlds: the tuner resonates the antenna and its feeder – *and* allows tuning out the reactance on the coax which runs between the tuner and the transmitter. An swr meter inserted in this line *will* show low swr, and furthermore the reading is honest!

The resonance indicator on the tuner is simply a dial light bulb in series with one feeder. (The system is balanced, so in theory, at least, the same current will appear on both wires of the feed line.)

A number 44 bulb will handle up to 35 watts or so – and if two bulbs are put in parallel, they will handle considerably more power. Higher power will require use of a Christmas tree light bulb, or, if *it* blows out, simply clipping a flashlight bulb over a portion of the feeder, as shown in Fig. 3.

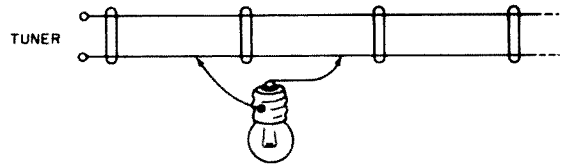


Fig. 3. Resonance indicator on feedline.

Step One

In tuning up any antenna system, I like to start out by tuning up the transmitter to a suitable dummy load. For example, with low power, a 40-watt oven bulb (the clear glass makes the filament easier to see than on a frosted bulb). As the first step it is always nice to know that the transmitter is putting out power.

Next, let's tune up on 28 MHz. Remove

the dummy load from the transmitter and hook up the coax to the tuner. Place the clips on the tuner coil in approximately the position shown in the photograph.

Set condenser C2 at approximately one-half capacity (assuming 150 pf).

Adjust the load controls on the transmitter so that meter readings indicate the antenna appears to be taking some power. Now rotate C1, and watch for the bulb to light. If it does not, throw the switch, and try again. If you still get no indication (chances are you will) move the clips either closer to the center, or further out. Try to have the same number of turns on both sides.

You may make a few false starts, but in a couple of minutes you should arrive at a point where tuning condenser C1 through resonance will cause the bulb to light. Now adjust C2 for maximum brightness of the indicator bulb, and "touch up" the tuning of the transmitter. The name of the game is to achieve maximum brightness on the indicator bulb without, of course, overloading the transmitter – which probably has a plate milliameter to indicate proper input.

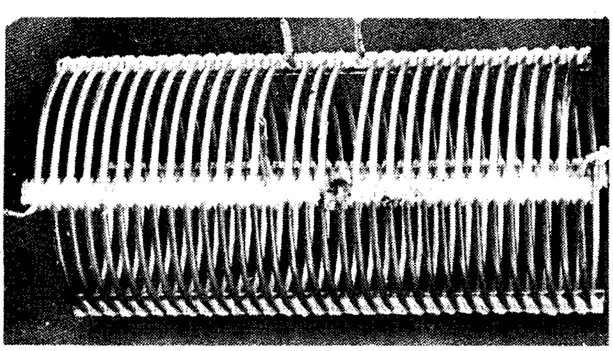
If you want to insert an swr meter into the coaxial line, now is the time to do it – and chances are very, very good that the swr will be quite low, although careful adjustment of C2 may bring it still lower.

Once you have discovered the proper tap points for 10 meters, indicate them with a dab of paint (or finger nail polish) alongside the clips so that it will be easy to return to the same spot.

Tune up on 15 meters and 20 meters follows exactly the same procedure. When you have maximum brilliance on the bulb you have the system in resonance and virtually a written guarantee that you will "get out."

Additional Bands?

Yes, the Mini Vee will tune up on the



Coil stock is clipped to form three coils.

other bands as well. It will tune up on 6 meters with the coil shown, and you may get it to tune up on 2 meters as well, although most of the coil will have to be shorted out and it would be better to use a smaller coil. The radiation pattern will not be a bi-directional "figure 8" (as will be true on the lower frequency bands) but rather a figure 8 plus a number of other lobes, many of which will be highly useful, and tend to give coverage in all directions.

In addition, the antenna can be used as a random length long wire (fed with an L network) on 80 meters and 40 meters so the Mini Vee is actually an all-band antenna. All of this can be done with a somewhat more complicated tuner plus a simple switching arrangement. But that is a story for another time – and perhaps the subject of another article!

...WØLBV

Technical Aid Group

Please refer any questions of a technical nature to one of the following members of 73's Technical Aid Group. These are dedicated amateurs who really want to be of help and do so without compensation. Be sure to state your problem clearly and enclose a S.A.S.E. for a reply.

John Allen, K1FWF, high school student, 51 Pine Plain Road, Wellesley, Mass. 02181. HF and VHF antennas, VHF transmitters and converters, AM, SSB, product data, and surplus.

Bert Littlehale, WA1FXS, 47 Cranston Drive, Groton, Conn. 06340. Novice transceivers, test equipment and homebrew projects gone wrong.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, New York 14619. Specializes in VHF/UHF solid-state power amplifiers, but will be glad to make comments on any subject.

G. H. Krauss, WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, New York 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitter and receivers, VHF antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Charles Marvin W8WEM, 3112 Lastmer Road, RFD #1, Rock Creek, Ohio 44084. Will help with any general amateur problems.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, New York 11360. Novice help.

PFC Grady Sexton Jr. RA11461755, WA1GTT/DL4, Hedmstedt Spt. Detachment, APO New York 09742. Help with current military gear, information from government Technical Manuals.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO New York 09665. Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

J. J. Marold, WB2TZK, 279 Farmers Ave., Lindenhurst, New York 11757. General.

Ira Kavaler, WA2ZIR, BSEE, 671 East 78 Street, Brooklyn, New York 11236. SSB transmitting, color TV, computer programming and systems, digital radio and remote control, rf transmission lines, dipole design, audio amplifiers, linear and class C rf amplifiers.

Fred Moore, W3WZU, broadcast engineer, 4357 Buckfield Terrace, Trevose, Pa. 19047. Novice transmitters and receivers, HF and VHF antennas, VHF converters, receivers, AM, SSB, semiconductors, mobile test equipment, general, product data, pulse techniques, radio astronomy, bio-medical electronics.

Walter Simciak, W4HXP, BSEE, 1307 Baltimore Drive, Orlando, Florida 32810. AM, SSB, Novice transmitters and receivers, VHF converters, receivers, semiconductors, mobile, test-equipment, general.

James Venable K4YZE MS, LLB, LLM, 119 Yancey Drive, Marietta, Georgia. AM, SSB, novice gear, VHF, semiconductors, and test equipment.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, Virginia 22042 General.

Wayne Malone W4SRR BSEE, 8624 Sylvan Drive, Melbourne, Florida 32901. General.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans, Louisiana 70118. Novice help and general questions.

Douglas Jensen, W5OG/K4DAD, BA, BS, 2505 Broadway, #1704, Houston, Texas 77012. Digital techniques, digital and linear IC's and their applications.

Louis E. Frenzel, Jr., BAS, 11287 Columbia Pike, Silver Spring, Maryland 20901. Electronic keyers, digital electronics, IC's commercial equipment and modifications, novice problems, filters and selectivity, audio.

George T. Daughters, WB6AIG, BS, MS, 1560 Klamath Drive, Sunnyvale, California 94807. Semiconductors, vhf converters, test equipment, general.

Glen H. Chapin, W6GBL, 3701 Trieste Drive, Carlsbad, Calif. 92008. HF and VHF antennas, novice transmitters and receivers, VHF converters, semiconductors, receivers AM, SSB, general, surplus.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, California 91780. ATV, VHF converters, semiconductors, general questions.

Steve Diamond WB6UOV, college student, Post Office Box 1684, Oakland, California 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, VHF antennas and converters, receivers, semiconductors, and product data.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, California 95240. TV, HF antennas, SSB, VHF antennas and converters receivers, semiconductors, and general questions.

Hugh Wells, W6WTU, BA, MA 1411 18th Street, Manhattan Beach, Calif. 90266. AM FM receivers, mobile test equipment, surplus, amateur repeaters, general.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, Calif. 94952. Double sideband.

Eduardo Noguera M. HKINL, EE. RE, Post Office Box Aereo 774, Barranquilla, Columbia, South America, Antennas, transmission lines, past experience in tropical radio communications and maintenance, HF antennas, AM, transmitters and receivers, VHF antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

D. E. Hausman, VE3BUE, 54 Walter Street, Kitchener, Ontario, Canada. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Frank M. Dick WA9JWL, 921 Isabelle Dr., Anderson, Indiana 46013. Will answer queries on RTTY, HF antennas, VHF antennas, VHF converters, semiconductors, mobile, general, and microwave.

Gary De Palma, WA2GCV/9, P.O. Box 1205, Evanston, Ill., 60204. Help with AM, Novice transmitters and receivers, VHF converters, semiconductors, test equipment, digital techniques and all general ham questions.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, Pennsylvania 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

William G. Welsh W6DDB, 2814 Empire Ave., Burbank, Calif. 91504. Club licensing classes and Novice problems.

Ralph J. Irace, Jr., WA1GEK, 4 Fox Ridge Lane, Avon, Conn. 06001. Help with Novice transmitters and receivers and novice theory.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 S.W. Salmon St., Portland, Oregon 97205. This group of radio amateurs will answer any technical questions in the field of electronics.

Ted Cohen W4UMF, BS, MS, PhD. 6631 Wakefield Drive, Apt. 708, Alexandria, Va. 22307. Amateur TV, both conventional and slow scan.

Howard Pyle W7OE, 3434—7th Avenue, S.E., Mercer Island, Washington 98040. Novice help.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, New York 11357. General.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, Illinois 61820. Antennas, transistors, general.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, Illinois 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, Wisconsin 53402. Novice transmitters and receivers, general.

John Perhay WAØDGW/WAØRVE, RR #4 Owatonna, Minnesota 55060. AM, SSB, novice transmitters and receivers, HF receivers, VHF converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

Ronald King K8OEY, Box 227, APO New York, New York 09240. AM, SSB, novice transmitters and receivers, HF receivers, RTTY, TV, test equipment, general.

Charlie Marnin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, Ohio 44084. General technical questions.

Michael Winter DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, Ohio 45342. HF antennas, AM, SSB, novice gear, semiconductors.

Paul Gorrell, high school student, P.O. Box 228, Mashpee, Massachusetts 02649. Novice transmitters and receivers, hf equipments, CB to ham gear conversion. Marine to ham gear conversion, Civil Air Patrol Communications, all aspects.

David D. Felt, WB6ALF, 79 East Highland Ave., Sierra Madre, California 91024. Semiconductors, IC's, television, test equipment, product data.

Robert Scott, 3147 East Road, Grand Junction, Colorado 81501. Basic electronics, measurements.

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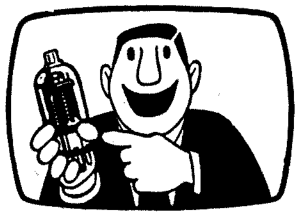


NEW PRODUCTS

Remote Control Relay

Alco's Remote Control Relay is a remote control component that combines a step-down transformer and a sensitive AC relay in a single laminated core that fits in a compact midget size package. It converts a 95-125 VAC power source to 30V that can be run through ordinary surface wiring without shocks and hazards.

Simply plug this relay into any outlet, and it provides the actuating voltage to a 110 VAC alarm or remote control accessory. It has a 3-way receptacle to select a Normally Open or Normally Closed circuit. The side jack serves as a plug-in for the remote switch or sensor.

28 Circuit Ideas Are Free

Our 28 Design Idea Booklet shows circuits on how to build typical remote control circuits of appliances; machine tools; TV commercial killers; fire, smoke and burglar alarms; garage doors; sprinklers—and other apparatus requiring safe, remote control circuits.

For further information, contact Alco Electronic Products, Inc., P.O. Box 1348, Lawrence, Mass. 01843.

Closed-Circuit TV Camera

ATV Research announces the availability of its new line of SOLID-STATE MODULES for building your own TV camera (vidicon type) or for updating existing cameras. Through the use of these wired, pre-tested, encapsulated modules building a complete camera can be accomplished in a single evening. No previous TV knowledge or special test equipment is required.

Modules include: (1) Video module, (2) Vertical sweep module, (3) Horizontal sweep module, (4) RF modulated oscillator module and (5) DC-DC HV module.

Using the first four modules, experimenters and constructors can build a complete TV camera (less power supply). Power requirements include 12V for modules and focus coil, 6V for vidicon filament and 200 volts for the vidicon control circuitry through the use of the (5) module which amplifies and rectifies the horizontal sweep pulses.

These modules are compact, light weight and economically priced from $10 to $20 per module. Each module comes complete with hook-up instructions.

Write ATV Research, Dakota City, NB, 68731.

Mod-U-Line Cabinets

Sorenson Electronics Co. introduces a complete line of electronic cabinets for the builder. Constructed of high strength H-34 hardened aluminum alloy, these cabinets can be twisted, dropped, drilled, punched, and still stand up with no distortion or misalignment of panels. Chip proof baked enamel finish in contrasting grays (other colors are available on special order) is applied over alodined surface. Available in just about any size any builder could want at modest cost. A catalog is available on request from Kaylor Electronic Products, 1918 Menalto Avenue, Menlo Park, California 94025.

The Guerilla

The life of an editor is fraught with many crises. Virtually upon the eve of my wedding day, I received an antenna in the mail. This was for evaluation and review. It comes from Dusina Enterprises of Melbourne, Florida. I have to admit that I asked for it.

In my term as Editor of *73*, I have tried to maintain a high degree of integrity in our advertising. If you look back a year or so, you will find many advertisers in the pages of 73 who no longer appear in the magazine. A few were voluntary "drop-outs." Most of them just didn't meet my rigid standards for honesty in their ads. After receiving complaints from some readers about false and misleading advertising, I began to scrutinize the ads more carefully. We lost a few good old customers in the process.

When an ad came in from Dusina, I was more than skeptical about their claims. I came close to not accepting their ad. I made an agreement that we would run the ad for one month, but I wanted to see the antenna. The antenna arrived on Monday. Tuesday morning dawned, cold and rainy. Being partially editor and partially idiot, I often refer to myself as "Idiotor" of 73. Today I really earned the title. At 10 A.M., I was up the tower at 75 feet tying the center of the "Guerilla" to match my existing dipole. Since the dipole is strictly for 75, and the Guerilla is for 40 *and* 75, I then spent the next hour

and a half cutting another dipole for 40, tying it at the 75 foot level, and tossing rocks at tree limbs to tie up the ends of the whole mess.

I am first of all a woman, I'm also a grandmother (albeit a young one) and have a degree of arthritis in my throwing arm.

By noon I was cold, damp, and tired. I had been up and down the tower four times and had thrown innumerable rocks over numberless branches. I took a martini break and, after checking resonant frequencies on all antennas concerned, started making some on the air tests.

What was I trying to prove? Well, the "Guerilla" is essentially a trapped dipole which claims 50% power gain (2 db) over a conventional dipole. My question was, "How can a dipole have *gain* over a dipole?"

Now, I pride myself on having an efficient antenna system. I am an incurable QRPer. I never run over 100 watts, so if I am going to communicate, I have to do it with the antennas. I consistently get good reports. I do a lot of operating on the top end of 75 meters and compete with kw stations all the time. So, I know my 75 meter dipole is good. At 3.999 my SWR is 1:1. At 3.999 the Guerilla showed 2:1 SWR. A station in Washington, D.C. gave the Guerilla 10 db over my antenna. A station in New Jersey gave it 1 S unit over my dipole, and a station in Buffalo (not in a favorable direction) said both were the same. On 40 meters, the resonant point of both dipoles were much closer, and the Guerilla topped my dipole on every report.

I have not answered the question of how a dipole can have gain over a dipole. For the time, I can only say that the Dusina "Guerilla" does have high efficiency to at least 2 db gain over my conventional dipole.

Basically, the Guerilla is a twin lead folded dipole, fed with twin lead feeders with a built in balun at the transmitter end. The overall length is 120 feet. The feedline is 50 feet. I found it necessary to go to RG58/U coax to reach the shack, but this still looked like 50 ohms at the transmitter. I can only assume the 2 db gain comes from the low loss in the twin lead over a coax feedline of over 100 ft.

The Guerilla comes with green nylon cord, built-in eyelets at the ends of the dipole, and lead weights for throwing over tree limbs. (The rocks were for my 40 meter dipole.) It is lightweight, easy to erect, and works! It is rated to take two kw PEP. The SWR curve is very flat on 40 meters, but has a more pronounced dip at resonance on 75. It is cut for 3.9 and maximum SWR is 2:1 on the phone band.

Available for $33.75 from Dusina Enterprises, 571 Orange Ave. W., Melbourne, Florida.

...W1EMV

Modifying a Tube Converter for FET Operation

L. C. Maurer, W6OSA
209 Nob Hill Way
Los Gatos, California

With the advent of VHF FET's, such as the TIS-34, at $1 or under, it becomes practical to remove the tubes from old style converters or receivers and replace them directly with Field Effect Transistors. The unit that I chose for my first experiment along these lines was a rather ancient VHF-152, 10, 6, and 2 converter (see **Fig. 1**). I decided to start with the ten meter band but in order to be certain of having plenty of signals for tests I moved the lower limit down to 11 meters, the C.B.'ers being very active in these parts. A 4 pf capacitor across each of the three ten meter coils did the trick, (dotted lines in **Fig. 2**).

It can be seen from the schematic that the VHF-152 is not wired like a conventional receiver front end. I don't say the VHF-152 is better, just different. Note the 18K resistor which serves as a plate choke for the 6AK5 *rf* amp. Obviously that will have to go before we can substitute an FET for the 6AK5.

Next comes the problem of neutralization. A typical VHF FET has about 1.5 pf capacity between its input and its output as compared with the .02 pf capacity of the 6AK5. There would seem to be two possible routes. Either use a conventional tapped plate (drain) coil and a neutralizing capacitor, or employ 2 FET's in place of the one 6AK5 in a cascode arrangement.

Because of the band switch consideration, it was decided to use the cascode approach. LI will serve as the gate inductance for Q1 and L2 will serve as the drain inductance for Q2. It will be necessary to lift the bottom end of L2 from ground and feed the plus 21 volts through it as in **Fig. 2**.

This particular model converter never did work well on 2 meters. One look at the band change switch will explain why. But, it was thought that the transistorized version would cover 10 and 6 meters in good style. Therefore, the band change switch was preserved. For 2 meter operation, a separate *rf* preamp which I already had on hand (refer to 73 Magazine, July, 1967, page 48) can be wired into the band change switch as shown in **Fig. 2**.

Because this was my first attempt at con-

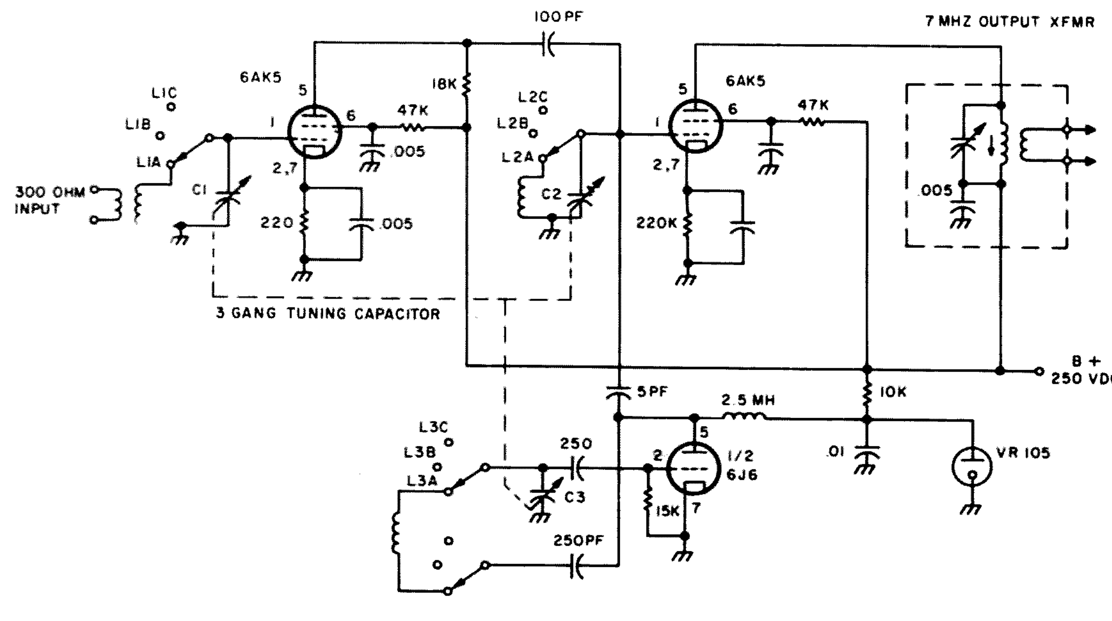


Fig. 1. Schematic for the 10, 6 & 2 converter.

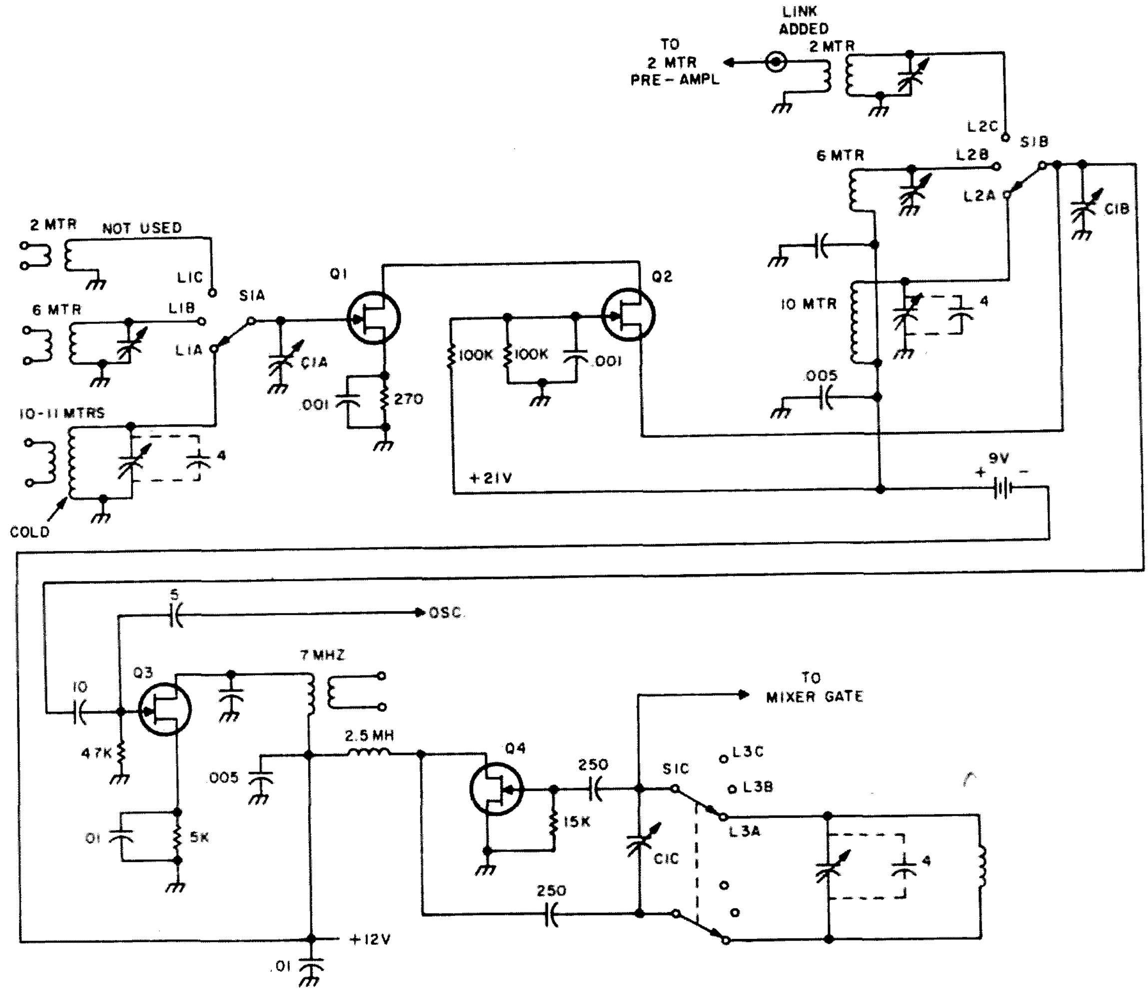


Fig. 2. Modification to FET.

verting from tubes to FET's, I used a cautious three-step approach. The idea being that if something didn't work, I would have a better idea where to look for the trouble. The 6J6 oscillator tube was removed first and a TIS-34 soldered to pins 2, 5 and 7 of the tube socket. I had expected that the injection voltage from the new FET oscillator might be a little low for a tube mixer but this did not seem to follow. The converter worked as well as ever with improved stability.

Next, I removed the 6AK5 mixer and soldered another TIS-34 to pins 1, 5 and 7 on the mixer tube socket. It was necessary to change the grid leak and cathode (source) bias resistors. Operating again as a hybrid with two FET's and the 6AK5 *rf* amp., the old VHF-152 performed better than it ever had in its life. I was almost tempted to "leave well enough alone."

The final step was to remove the 6AK5 *rf* amp and replace the tube with two FET's. In this type of cascode circuit, the FET's are in series so it is desirable to increase the voltage to some value between 18 and 24 volts. What I actually did was to add a small 9 volt transistor battery in series with my 12 volt regulated power supply. In the original VHF-152 circuit, the bottom of L2 was grounded (refer to Fig. 1). It was merely necessary to lift the ground, bypass it, and supply the 21 volts as shown in Fig. 2. The ideal situation would be to have the voltage drop across Q1 and Q2 approximately equal. If you use transistor sockets, you might try swapping Q1 and Q2 back and forth to get the best arrangement. The gain of the stage is determined almost entirely by Q1. You can even use an NPN bipolar transistor such as the 2N706 for Q2 if you wish. The voltage divider for the base bias should consist of two 6K resistors instead of the pair of 100K resistors shown in Fig. 2. No other change is necessary.

Now comes the part that is a real pleasure. The power transformer, choke, rectifier tube and VR tube can be removed from the VHF-152 chassis and deposited in the junk box. The new VHF-152 is ten pounds lighter than

DX Quiz . . . Answers

Here are the answers to the country quiz on page 56.

1M4	Minerva Reef*	7G1	Republic of Guinea
1S9	Spratley Island*	7P8	Lesotho
		8F4	Indonesia
3W8	North Viet Nam	9A1	San Marino
		9F	Ethiopia
4M	Venezuela	9H1	Malta
4Z	Israel	9K3	Neutral Zone, Kuwait/Saudi Arabia
5B4	Cyprus		
5L2	Liberia		
5R8	Malagasy Republic**		
5T	Mauritania	9M2	West Malasia
5U7	Niger		
		9X5	Rwanda
		9Y4	Trinidad & Tobago

*As far as we know, no operator has legitimately operated from these countries as yet.
**Madagascar is not correct.

the old one used to be. It is more stable and its signal to noise ratio is improved. It can be operated entirely from small inexpensive batteries if desired.

Although the above remarks appear to be aimed entirely at the VHF-152, I want to emphasize that any converter, or receiver front end for that matter, can be converted to FET operation by following the same basic procedure. One word of caution; if you use the step by step approach, be sure to remove all wiring from the "B" plus 250 volt supply which might come in contact with the new FET before attempting to operate in the hybrid mode. Also, be careful about the battery polarity. It is sudden death to reverse the battery on an FET stage.

The TIS-34 is an N-channel FET and there are several other types which would no doubt work equally well. Make certain that the one you select is rated to operate at the highest frequency that you intend to operate the converter. A bipolar transistor can certainly be used in the oscillator stage. I don't recommend bipolars for Q1 or for the mixer stage because I like to preserve the hi-Q and image rejection of the tuned circuits in LI and L2. It would be difficult to tap down on these coils due to the band change switch.

...W6OSA

(...de W2NSD/1 continued from page 2)
stay CB'ers...or Technicians. Keep after them. Get them into your club and keep them coming to meetings. We've certainly published enough information on how to make club meetings interesting and valuable so you have no excuse for letting your club fail.

The United States twenty years from now will reflect the interest and effort that *you* show today. Electronics will be reaching into every aspect of life then. Schools will be using computers and television more than we even envisage today. Communications satellites will put every home and business in instant touch. Every person, for that matter, may well have a personal phone right with him at all times. Well...almost all times. Credit cards may be used for even the smallest purchases. Just stick it in the slot and your account will be debited from anywhere in the country.

Both on the military and economic fronts, the strength of our country in the future will depend heavily on electronics. We have a lead right now, but can we hold it? You know darned well that Russia is aware of this for they are organizing amateur radio on a level that is leaving us behind. They emphasize the fun over there. They have elevated amateur radio fox hunts to a national craze, with regional championships and then enter national championships. Thousands of clubs participate in this.

In a large measure the future of the country is in your hands. If you have a club, get it into action. If you have no club in your area then start one. If you can't do that, elect yourself a committee of one to go to your local high school and sell ham radio. Get those classes started. Call the school principal today and see if you can arrange to bring down some equipment and QSL cards for a talk in assembly or to the science classes. You certainly can take one night a week off for an hour or two of classes. Or even a Saturday?

...Wayne

Ham Hospitality

Some years ago an organization sprung up in Europe called the Ham Hop Club. The basic idea of this club was a good one, but the effort floundered as the paperwork grew with the size of the club and no one could be found to do the work for no fee.

The Ham Hop Club was set up to enable hams visiting other countries to meet and stay with the local hams. The club, on getting a copy of your itinerary, would. write to members in the countries you planned to visit and arrange accommodations for you. This was a lot of work and took a lot of time.

I made very interesting personal contacts in Paris, Rotterdam, Amsterdam, and other cities as a result of the club, though I preferred to use hotel accommodations rather than put people out with overnight visits. It was through the Ham Hop Club that I met Pierre, F2BO, who later came to New Hampshire to work at 73 and went on to successful work at the University of New Hampshire.

In almost all of the 80 countries that I have visited so far I have been met and entertained by hams. I can testify that ham hospitality is first rate. For some time now I've been wondering what I might be able to do to help get local hams together with visitors. Setting up an office like the Ham Hop Club was obviously out of the question. Perhaps I now have an idea that will work. It seems worth a try.

It has been my experience that when I visit DX amateurs that I benefit tremendously. First of all, the warm welcome makes the city or country seem much more friendly. Secondly, my host is able to explain the customs and mores of the people so that I can understand them. Thirdly, I love to try new foods and often I am treated to a dinner of local specialties which are exciting and fun. In return I find that there are an almost infinite number of questions about the United States that are waiting to be answered. Foreigners read about us all the time, but they have no way of knowing how we look at and understand our own country. They want to know about how our people really feel about the racial problems...Vietnam...how we think of their country, etc. What do we think about our changing morality...big business...politics ...revolt. They want to know about all of those things that QST says you shouldn't talk about on the air.

The DX amateurs that I have visited and talked with seem most enthusiastic about entertaining us W's. I might just offer a warning though that invitations be worded explicitly. I have known U.S. amateurs to accept carelessly offered hospitality by turning up with wife and two children, hitch hiking with full back packs, intending to stay for some weeks.

It seems worth while to me for us to make a try at getting hosts and travelers together through the pages of 73. If you are interested

in extending hospitality to a visiting amateur, write and let us know the details of your offer. We will in turn publish it, and from there on it will be between you and the travelers. Please keep your Ham Hospitality notices brief. I suggest you start with your city and state or city and country for DX. U.S. amateurs should specify DX or W/DX. Specify OM/XYL/children. Few families do much traveling with their children, but if kids would spoil the visit just say OM/XYL. If you and your wife have any other interests you might list them...travel, photography, skiing, occult, etc. Give your address and phone number. Users of our Ham Hospitality service will be requested to write or call as much ahead of time as possible and to recognize that all of us have plans that we don't want to break and that all offers are contingent upon the time being open. Try and keep your offer to 30 words or less please.

Sample:

Peterborough, NH. DX OM/XYL, overnight/dinner, local sightseeing and rag chewing. Interests: travel, photography, skiing, skin diving, Mensa, art, occult, UFO's. Wayne Green W2NSD/1, Peterborough NH 03458. 603-924-3873.

...Wayne

Gentlemen's Agreement

Many AM holdouts on our 20M band keep bringing up a "gentlemen's agreement" which guarantees them permanent exclusive use of lower half of the 20M phone band. For the information of those of you who have entered amateur radio during the last ten years, there was indeed at one time such an agreement.

Back in the early years of sideband the pioneers were not interested in working DX. Indeed, attempts at it were rather futile, since very few DX operators even had an idea of how to tune in a sideband signal. I remember visiting OE1ER in Vienna back in 1958 and finding that he was under the impression that his receiver (AR-88) wouldn't tune in sideband. I showed him the technique and broke in on my good friend W2CFT, calling on AM. Al said hello to us immediately and it wasn't many moons before OE1ER was heard with a rather potent sideband signal.

Since they couldn't work DX, most of the sidebanders congregated on the non-DX end of 20M, the high end. At first they took up the top 20 kHz (they were kc in those days, alas). Then, as more fellows found out about the advantages of SSB, they gradually expanded...30 kHz...40...50! At about this time, the phone band was extended from 14.3 to 14.35 and the SSB crew filled the 14.25-14.35 segment almost immediately, leaving the 14.2-14.25 segment for AM.

But by now more and more DX stations were getting into the act and learning how to work the sideband stations. And even worse, from the AM point of view, every now and then a DX station would change over to SSB. Even the unthinkable happened...a DXpedition operating on SSB instead of AM! The sidebanders found that they had to tune up on the low end of the band to work these DX stations and that was when the gentlemen's agreement went out the window.

With some intelligent leadership the AM'ers might have rescued the situation for themselves by regrouping on the high end of the band. Their opportunities for working DX were fading away and there really was no good reason for sticking to the low end other than stubborness.

Unfortunately for the health of our hobby, the same personality traits that kept fellows sticking to AM when the rest of the world was changing to sideband, also kept them on the air bitching about things and generally trying to make as much of trouble as they could. This, of course, does not apply to all AM ops, but it does to enough for us to make a good general case.

When I operate I try very hard to be as polite and helpful as I can. Sometimes, I feel quite a strain and I discover that I feel like quitting for a while. I wonder if it is really necessary for us to make it so difficult for the FCC to take the licenses away from fellows who have serious psychological problems and insist on venting them on the air.

I digress; as usual.

Perhaps it is time for us to initiate a new "gentlemen's agreement" for the AM'ers on 20M. It would make life a lot easier for them...and certainly for the rest of the resident 20M ops, if they started working from the 14.35 end of the band, as the SSB'ers did when they were as rare as the AM ops are today. I'm open to any good reasonable arguments for or against this...but if you find yourself hot under the collar, wait until you cool off and can write an intelligent and well thought out letter which will be of interest and value to us all. We have enough emotional harangues on the air and they are not needed in print.

Z-1000 Certificate?

Would there be any interest in a new type of certificate? I have in mind something the

reverse of the A-1 Op certificate. Should we have some permanent memento that we can send to ops who demonstrate on the air their stupidity, their thoughtlessness, their lack of consideration for others, and other lousy characteristics which go to sour the average amateur?

A nice big certificate, edged in black, could be sent to any operator who has made such an ass of himself that a bonafide amateur radio club has taken the effort to submit an official censure memorandum to us. We could then issue the certificate, printing the detailed complaint on it and the calls of the club members who have lodged the complaint. We might also send a copy to the local FCC office for their information.

What is your reaction to this? If you don't like the idea, what can you offer as a positive suggestion that we might all be able to do to help straighten out these either thoughtless or "sick" ops that are botching things up?

Wayne

Covers?

We need interesting and colorful covers for 73. Perhaps some of our readers are artists and can paint some good covers? Or can you photographers come up with some cover ideas that will help us sell more magazines on the newsstand? Our newsstand distributor is most adament that we should have a person on the cover as well as equipment, parts, a tower, or whatever. And if this person happens to be gorgeous so much the better.

Keep in mind the aspect ratio of our cover format. We can vary from this, but we tend not to. We can work from color slides of the regular 35mm type, or from larger color positives or negatives. We can work from color enlargements too. And of course we can work from original oil or watercolor paintings or pastels. Paintings should be about three times the finished size.

Cover ideas are hard to come by, so see what you can come up with. Remember that we run special issues now and then devoted to surplus, antennas, vhf, dx, transmitters, receivers, and such. RTTY, ham-tv slow-scan tv, moonbounce, dishes, and other ham developments are all worth while for covers.

We are paying a fortune to reprint color pictures on the cover so be sure that your entries are colorful...have good composition ...and are sharp and clear.

FCC Action

Perhaps "action" is an exaggeration. At any rate the FCC on March 11th announced that they had extended the time for receipt of comments on the petition by John Attaway, K4IIF, to hold up on extending the Extra Class CW bands on November 22nd since the present allocations had yet to be adequately used. The extension was until April 7th. Since the next possible issue of 73 that we could get the news of this extension in would not be in the hands of readers until April 25th or so, we did not fall all over ourselves to get this notice into print.

If you feel that the FCC is rushing things a little with their intention of opening up another 25 khz to the Extra Class for CW, come November this year you might sit down at a typewriter and compose your thoughts on the matter, giving all of the arguments you can think of to back up your proposals. Address these to the Secretary of the FCC, Washington, D.C. 20554, and send along the usual 15 copies to make it official. It does not hurt to get a notary on the original copy.

The FCC will continue to slough us off as long as we remain disinterested enough in our own fate to keep our opinions to ourselves. If the FCC doesn't get any more mail than I do about these things then they are absolutely right in dismissing us as unworthy of much consideration. If anybody cares much about what is going on they are keeping mighty quiet about it. The squeaking wheel gets greased. Office copiers are just about everywhere now so there is little excuse in not making up those silly 15 copies and filing your opinions officially.

Wayne

Ontario QSO Party

All amateurs are invited to participate in the Ontario QSO party sponsored by the Radio Society of Ontario, Inc. The contest will run for a 31-hour period from 1700Z July 19, to 2400Z July 20. There are no power or band restrictions. Ontario stations score 1 point per contact and multiply by the number of ARRL sections and foreign countries worked. Others score 3 points for each Ontario station and multiply by the number of countries worked on each band. Ontario stations send QSO number, report and county. Others send QSO number, report and section. Logs must be postmarked no later than August 31, 1969, and sent to: Contest Chairman, Radio Society of Ontario, Inc., P. O. Box 334, Toronto 18, Ontario.

LETTERS

Last year, at renewal, I wrote a somewhat critical note stating that I thought the quality of 73 had degraded. As you can see by my 3-year renewal I don't feel that way anymore. Although I do believe that your magazine is not as "good" as it was 2-3 years ago—I think it's improving qualitatively issue by issue.

I would like to give you some of my thoughts regarding the state of amateur radio.

First of all, after I received my latest renewal from ARRL-*QST*, I decided the hell to the ARRL. I am discouraged Wayne, that a bunch of 70 year olds—living in a consciousness of the 1940's (at best)—are trying to run a (the) ham radio organization and amateur radio itself. When I read those assinine editorials—as I have in the last few issues of *QST*—about restricting freedom of speech on the air to nice safe, non-controversial topics I become upset for the future of our hobby. As you are well aware, the average QSO is the most repulsively dull conversation imagineable. Further, I am discouraged that these same 70 year olds—with the help of many fuddy-duddy engineer types—railroaded thru that damn incentive licensing giving the granddaddies lots of privileges and effectively "wasting" the lower 25kc of our bands (listen how void they are of use). Third, I am discouraged about the racism that I hear on the air and that I sense when I meet fellow hams. Amateur radio appears to me to be one of the most segregated hobbies in American culture. At a time when our hobby is hovering near increasingly faster (sharper) declines in new applicants—and perhaps air space—we should go to Boys' clubs, etc., in the inner cities and help set up at least club stations. But I sense that many hams are afraid that such communication potential may be used in riots for other than avocational purposes—such a ridiculous argument presumes of course that other forms of two way communication are not available—and they are. But, I guess that the real reason inner city kids are not introduced is because hams are fuddy-duddy—old and mainly traditional, solidly middle class, and scared. (Lack of equipment availability I do not see as a problem.) In fact, if you peruse the pages of *QST* you see lots of lines devoted to trivia, i.e., what Joe Ham is doing in the Midwest section with his new Drake Line, etc., or gobs of stuff on that puffed up public service bit called civil defense (excepting natural disasters), but little of social significance.

And, yes, Wayne, even you have been quiet on the turmoil in our society—focussing instead on safe stuff like USO nets, etc.

At a time when long distance telephone rates are cheap, telephone accessibility is so widespread there is little public service left that hams do, excepting certain overseas patches. Traffic is a slow farce; civil defense can be better (and has been) handled by CB'rs; and contributions to the electronics industry and our national defense is a delusion we allow ourselves but which is actually groundless when one considers how laggardly the state of ham technology (homebrew) is and how few young people participate in our hobby.

All in all—hams need a good kick in the butt, and probably deserve to lose frequency space considering the outmodedness of our hobby.

Gerhard J. Hanneman, WA8VBN
Michigan State University
East Lansing, Michigan 48823

While I am unhappily acknowledging Kayla's happiness, I will take the opportunity to say I'm sorry to know you are losing such a fine editor. She has a unique way of putting a feeling of friendship into "73." I suppose it is achieved simply by being friendly. She will be missed.

I am very glad to learn from your editorial how well you have succeeded with "73" in so short a time. You are to be congratulated, indeed. I rather doubt that it is getting too big for you as I am sure you are growing with it and are capable of handling its future growth, which, I hope, will be somewhat more than considerable.

While I am at it, toss my thanks to Zaranski for his article, "Minimum Cost Semiconductor Survey."

Also, I have for a long time wanted to thank Robert Suding for his article, "A Cheap and Easy Frequency Counter," November "73," 1967. I note in the current issue of "73" "Looking Back," refers to Votipka's counter, Nov. 1968 as being "over-simplified," and difficult to build. As I am about to revise my counter constructed from Suding's article with a few modifications, such as wave former and input gate and reading for one second, displaying one second, then repeating to update, I would appreciate it if you will use the enclosed SASE to forward the material mentioned on Votipka's counter (Nov. 1968).

If I recall corrently there was one omission but no errors in Suding's article, which remains the simplest and cheapest counter I have seen to date. It worked perfectly the first time I connected it up.

Again, congratulations on your excellent publication, the excellence of which its growth will continue to show. And, again, my regrets that the world, you and me, have lost our fond "Editorial Liberties."

C. W. Pate
Bryte, California

I know letters like this must be a pain, but if you would print this, I would appreciate it. It's to ask if there are any Swedish or English hams with whom I could exchange correspondence, cause om-a-goin' there. Naturally I would like them to be near my age (17), and longhairs, (you know, radical trouble-making whipper-snappers like I obviously must be). I write to you because of all the magazines, yours seems to have the readership with the largest number of people like me. I mean that as a compliment, you know. Thank you.

Richard Klein, WB22TN
(Sorry, can't help you leftist fellow-travelers—ed.)

Your March 69 issue of 73 *Magazine* was especially pleasing to me. The W1EMV and W2NSD/1 editorials continue to be outstanding; however, it was a most pleasant surprise to find an *open letter* to the editor by our old friend, A. David Middelton, W7ZC (page 71). In his typical straight-from-the-shoulder style, without repetitious "gobbly-gook," Dave conveyed his message to the reader. To the best of my memory this is the first public article by W7ZC I have seen in almost five years. What a void to hamdom!

I am appalled by the inactivity or loss of so many fine writers and club editors. In the past five years and particularly since the questionable "Incentive" Licensing action there has been a definite lack of controversial articles and "think" items for the amateur radio readers. As the result, amateur radio is suffering immeasurably by this loss of material. Since the innovation of the "incentive" ruling, radio amateurs are resorting to small independent cliques, uninterested in the overall picture because they have been subjected to one-sided information, or worse—no opinions at all!

During the promotional years of supporting amateur radio reciprocal licensing in this country, readers consistently found numerous excellent debatable reading matter in several magazines and club bulletins (but very few ever appeared in QST, I might add). These were the product of a great number of quality writers, many of whom were non-professional, but who have since chosen to remain dormant or have totally given up crusading in behalf of hamdom.

DX Magazine from Burlington, Kentucky, and The Monitor from Dallas, Texas, topped a long list of excellent periodicals, most of which have been discontinued. The Kentucky publication, edited by Don Chesser, W4KVX, and assistant editor Bob Knapp, W4OMW, was eagerly read by every *thinking* radio amateur. This same keen interest was directed to The Monitor, edited by courageous Joe Martin, W5RYP, and his talented staff of associate editors J. Foy Guin, W4RLS, A. David Middelton, W7ZC/W5CA, and Len Collett, KZ5LC; Oklahoma Editor, Doris Anderson, K5BNQ; Indiana Editor, Phil Hunsberger, K9PNT; Maryland Editor, Mari-Anne Payton, W3LQY; Nevada Editor, Leonard Norman, W7PBV; Circuit Board Editor, Walter Stevens, K5ICV; Virginia Editor, Van Wimmer, WA4BIX; Texas Panhandle Editor, Phil Patterson, W5SFW; and Mississippi Editor, Eddie Livingston, K5VOK.

The Institute of Amateur Radio, Inc. (IOAR), offered the hams outstanding "think" material by two well-informed writers: Wayne Green, W2NSD/1, and A. David Middelton, W7ZC. Dave also served for a time as the secretary of IOAR. Although sorely needed by all of hamdom, radio amateurs did not have the foresight nor the capacity to discriminate between facts and personalities—with the drastic result that the organization was not sufficiently financially supported. To concurring hams this meant that a sound and effective program was temporarily shelved. The Institute is amateur radio's solution to provide a much needed legitimate lobby in Washington, D.C. My personal opinion is that IOAR, properly supported will furnish the healthy competition required to "force" ARRL into providing a true democratic representation for its members and USA amateur radio. Reactivated and strongly assisted, the Institute of Amateur Radio can still provide the necessary liaison and lobby in our Nation's capital, a function vitally needed to improve and correct our present serious deficiencies. The end result will provide Congress and the amateurs with immediate factual and current information relative to Stateside as well as world-wide amateur radio activities.

You may remember other excellent writers during the pre-incentive licensing era: Dorothy Strauber, K2MGE/W4MYE, assisted by her energetic OM Irving, K2HEA, who edited The Sidebanders, published by the Single Sideband Amateur Radio Association. (Dotty also had a column going in CQ Magazine.) That vigorous staff included Ralph Mason, DL4PI; Harriet "Sunny" Woehst, K5BJU, as the YL Editor; Phil Carter, W1CRA; and James L. McCoy, K5GCE, who wrote under the by-line of "The Real McCoy."

From Europe came the extremely provocative articles of the very talented Frank E. Mortensen, W7HNT/WA6YNG, under his by-line "Let's Be Frank" which appeared in the SARA STATIC issues of the Spanish-American Radio Amateurs in Sevilla, Spain, and the QRZ bulletins of the Bitburg, (Germany) Amateur Radio Club. Both of these club periodicals were widely distributed world-wide. Frank's articles were directly responsible for the tremendous world support that resulted in the eventual passage of the reciprocal licensing bill into law.

What has happened to these fine writers? What has discouraged them from submitting timely articles? There are sufficient problems in today's USA amateur radio sphere to warrant and attract the controversial/think writers. Could it be our lack of interest? Least you forget, amateur radio owes a great deal of its development and progress to the polemical and "think" pieces from well-versed and qualified personnel whose written opinions over the years gave each of us the necessary background to weigh, with an open mind, the dialogue needed to reach a valid and realistic decision. Those writers, plus many more unmentioned in these comments, recognized the need during that period to provide hamdom with varied open-minded opinions.

Today, more than ever, amateur radio should find a place for the opinionated thoughts of its writers. Too, there is a place for the reporter-type who can publish in his own town or city newspapers or commercial magazines, the amateur radio events as they happen. But, primarily we need to recall all of those authors who, by writing their own thoughts can make us more knowledgeable and conscious of what is happening to amateur radio in our country. We must be shocked into thinking and acting immediately! This is no time to waste on those writers who are fearful of "rocking the boat."

I hope to see more inputs from David Middelton. Perhaps he can awaken the interest of those dormant authors. There are many of us who want to see their articles in the pages of our favorite magazines and other periodicals. With the continued absence of the journalistic efforts of qualified controversial/"think" writers, the USA radio amateurs cannot expect any improvement in present conditions—in fact, we will continue to live with token "representation" and degradation that is occurring in our ranks. Too, we must be cautious of accepting the opinions of "self-styled" journalists who author the "expert" overseas picture after one short visit to a foreign land. In the eyes of our DX friends, these writers create more serious harm than good. Instead, let us encourage those fine experienced penmen into reactivating their efforts in order that we may regain the courage to correct our own problems. Whether or not we recognize it, amateur ra-

dio in this country today is in greater jeopardy of surviving than ever before!

John F. Barrows, W6ECS
Fairfield, California 94533

I am a great fan of your magazine and wouldn't trade it for anything. But, for a long time I have wondered why you haven't started your own Field Day Contest. I feel this would help a lot of people to like the magazine a bit better. So, keep up the good work and think about this. You have a lot of good articles on contests, but you don't have any contests to use them on that I know of.

David Brittenham, WAØRVK
Monett, Missouri

No, no contests. Somehow we had the feeling that perhaps there already were enough contests. However, if a major radio club would be interested in volunteering to run a new type of field day event, complete with the scoring of the logs, we might just consider it. We had in mind a contest which would be short and unannounced to simulate emergency conditions...ed.

I think your technical articles are great. If possible, more on conversion of commercial FM gear in the VHF range (6M & 2M).

I am an E.T. by profession and rate 73 Magazine as high as any trade or hobby magazine on the market today.

Many thanks to all the fine engineering people who contribute articles in laymen terms.

S. L. Thompson, WA5NXT/Ø

One of the finest articles on antennas ever carried in any magazine was in the April 1966 edition of 73, by Robert Cooper, *Ascendency Curve Yagi*, p. 20. I built a 3EL Yagi for 20M based on his maximum gain curves and it was far superior to commercial beams. How 'bout an article dealing with Maximum Gain for Quads–element spacing lengths, etc. Keep up the good work.

Greg Milnes
Hillsboro, Oregon

I saw it first in your 73 Magazine in November 1966 on page 52. Next it shows up in "ham radio" for April 1969 on page 34, three years later. Can they get a patent on that?

I Am Curious

Dear Curious: Nothing to turn yellow over. W2-WLR does seem to have managed to rediscover a diversity antenna very close to that described by W4TDI in 1966. These have been popular for many years for point-to-point communications where fading is a problem (RTTY, etc.). The low angle radiation is deceptive in high sunspot times when signal reports can be most exciting from areas where the band is just opening. Unfortunately, once the band is open, a very low angle antenna will lose your signal in the qrm. Ask anyone using that most remarkable low angle Twin Three (or ZL-Special) antenna what happens after the band is open or when the sun spots are gone. When "ham radio" announced the W2WLR antenna for their April issue I thought that this was appropos and fought off the strong temptation to discuss it in our April issue.

Here are a couple of photos of my ham TV station which I spent about five years constructing and working out the bugs so now I have a *snow-free* picture up to seventy miles from here. More later, if you are interested. However, I will mention a few stations I work very often and always snow-free in any kind of weather such as K8TME, Damascus, O., WA8DZS, Mount Union, Ohio and also WA8-OKS, same QTH, K8EWX north of Alliance, K8WMA south of Alliance. All of us really appreciate your interest in ham TV but would like to see much more on TV in 73 from other successful TV'ers. Obviously, this is the coming mode in many amateur stations in USA. I think this is the King of all electronic hobbies. Sure is terrifically thrilling. By all means, keep up the good work in your 73 or we ATV'ers might have to throw in the sponge.

Les Miller, W8ACH
Alliance, Ohio

I would like to thank you for a job well done on "Amateur Radio Knows No Borders." It is this type of report that makes me proud to be a member of the amateur fraternity.

J. Stoutenburgh, WNØWDX
Minneapolis, Minnesota

An item of interest for your magazine is the fact that both houses of the Alaska State Legislature have passed by an overwhelming vote House Bill No. 103 which relates to the annual license tax on vehicles containing mobile amateur radio stations. Under the new law, rather than pay $30.00 for a license plate, an amateur holding an FCC license and with mobile capability of 75 meters through 10 meters may obtain his license and his call letter license plates for a total fee of $1.

The idea behind the Bill was to encourage amateur radio operators to equip for emergency use. You will recall that in the case of the Anchorage earthquake in 1964 and the Fairbanks flood in 1967, the power was off and regular communications were completely disrupted for a substantial period of time. In both cases radio amateurs provided an emergency link-up until power and normal communications were restored. In these days of zoning regulations which cramp amateur radio, TVI complaints and million dollar lawsuits, it is heartwarming to see the policy of a sovereign state of the Union recognizing the unique capabilities of the amateur radio fraternity, and I think an appropriate article in your magazine might well be an eye-opener for other parts of the nation. Truly, the entire country should support the principle set forth in Alaska's House Bill No. 103 for no one is completely safe from natural disasters.

Douglas L. Gregg, KL7FPA
Juneau, Alaska

The TIS34 is popular in Amateur construction projects, but is hard to locate "over the counter." It is available from TI Supply Company, 6000 Denton Drive, Dallas, Texas 75235, as a 2N5248/TIS34. The present price for 100 units is $1.10 each.

Ed Lawrence, WA5SWD
Plano, Texas 75074

A Variable Resistance VFO for 6 or 2

Roger H. Taylor, K9ALD
281 William Street
Champaign, Illinois

Another Stable VFO

Voltage tuned variable capacitance diodes have been with us for almost ten years. They have been featured in a few general applications articles, and they are showing up in a few commercial SSB transceivers. However for being such useful little animals, they have seen very little use in ham articles. A considerable effort is made in vfo designs to provide mechanical rigidity in the tunable element, whether coil or capacitor. Yet, here is a completely rigid device which has seen little application. Obviously, what follows is a vfo using the voltage tuned variable capacity diode, and also an encapsulated coil to eliminate mechanical problems.

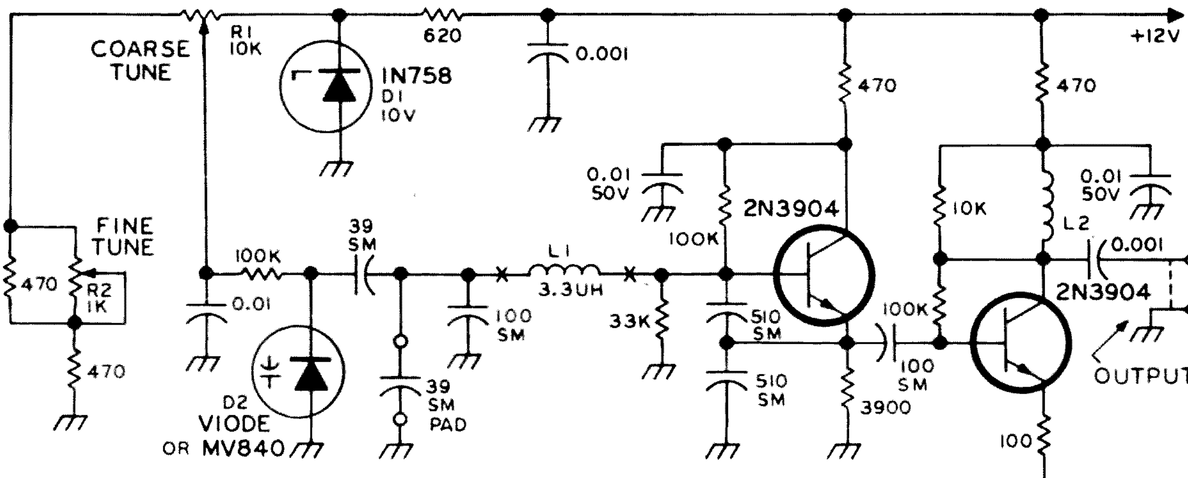


Fig.1. Schematic diagram, Colpitts oscillator.

Two models of the vfo were constructed. One features two miniature potentiometers for coarse and fine tuning. The other has only one standard, a lower cost pot. for the economy minded. The circuits are identical except for the added pot. The schematic shows the standard series tuned colpitts os-

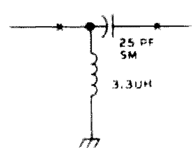
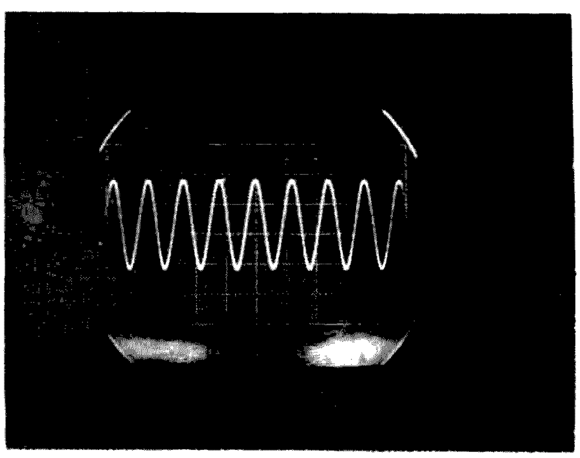
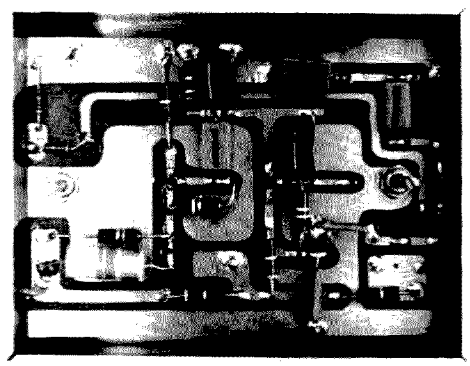


Fig.2. Parallel tuned version.



Look at those nice sine waves.



Bottom view.

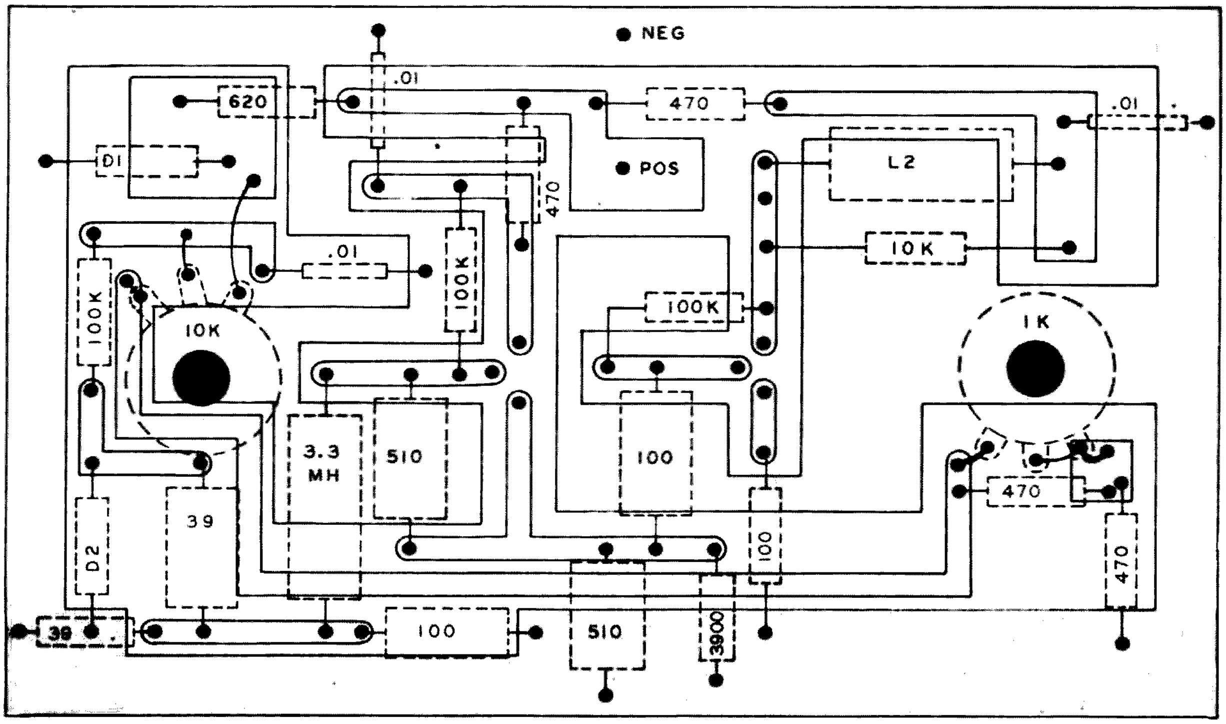


Fig.3. One side of printed circuit board.

cillator in **Fig. 1**. If you prefer the parallel tuned version, simply modify it according to **Fig. 2**. The series tuned version seemed to give slightly better stability with supply voltage variation.

The voltage to the diode is regulated by the zener diode. The .001 capacitor is for filtering any ac or noise. It could be almost any value. The 100K resistor is for isolation of the diode. An rf choke could be used, but would introduce more reactive components into the critical tuned circuit. The output coil, L_2, is chosen to resonate with the length of coax to the next stage. If no coax is used, 15 uH is the correct value. If maximum output is desired, a smaller coil can be used and a trimmer capacitor added to tune the output rather than cut and try on the coax length. The 10K resistor across the output just loads it and broadens the response. The output should be at least 15 volts peak to peak into 10K ohms of good clean sinewave (unlike some other vfo's).

The values given are for a frequency of 8.3 to 8.5 MHz. Changing the padder quickly puts it in the two meter range from 8.0 to 8.2 MHz. The unit is quite stable with voltage variation from 10.4 to 15 volts or more. You can shut the oscillator off in several ways such as: grounding the base, opening the emitter, or simply switching off the supply voltage. Normally the latter is not too satisfactory, but no turn-on drift could be detected. Everything is rigidly mounted to the pc board. The components should be mounted on the back for easier soldering. I mounted most of them on the front to show their placement better.

The two pot. model is recommended for SSB since it is easier to zero beat, or the one

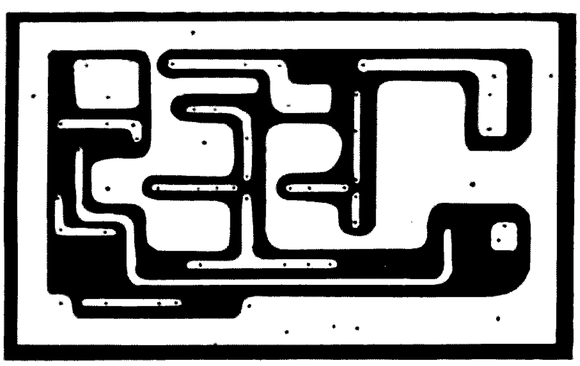


Fig.4. Parts mount on one side of board.

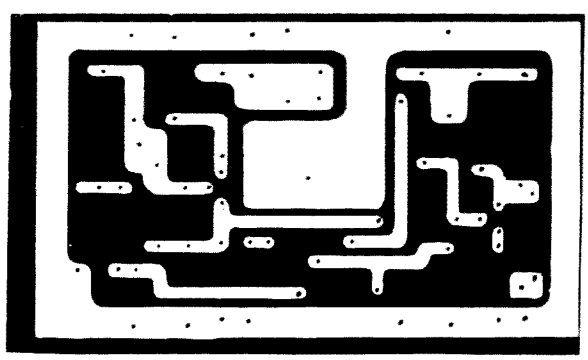


Fig.5. Other side of board.

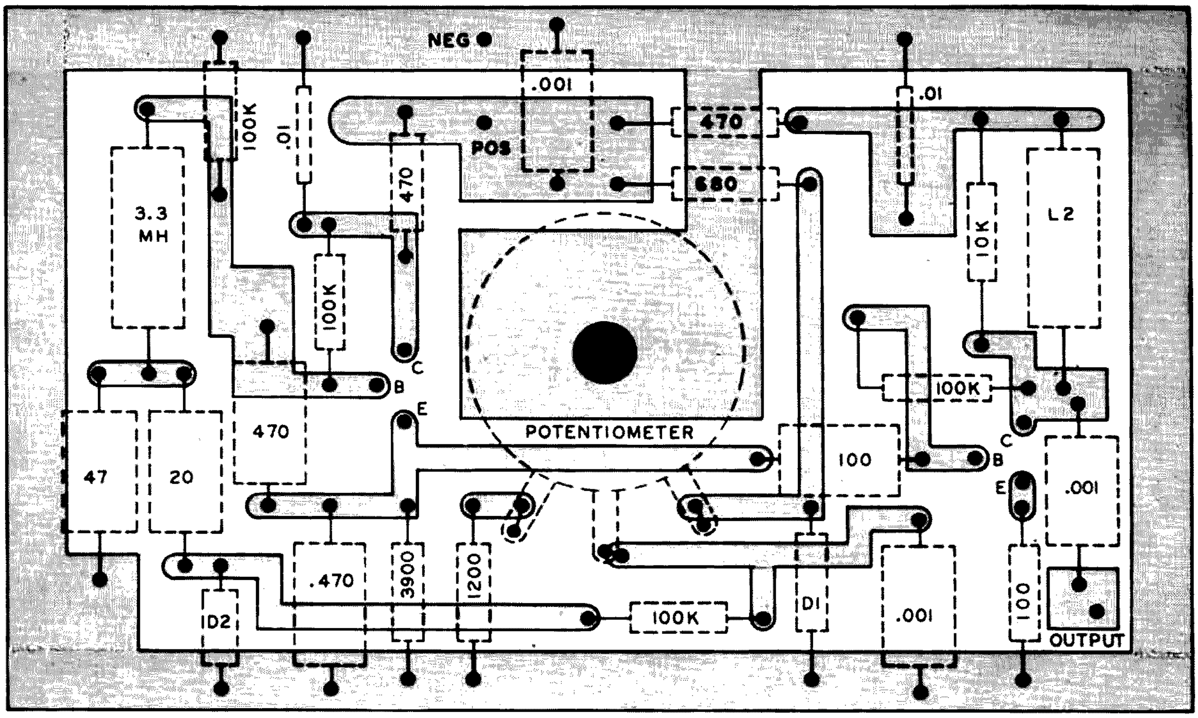


Fig.6. Parts placement on other side.

pot. version can be used with a vernier. You can make a vernier from the tuning capacitor in the "lunch boxes" or Lincoln transceivers. Lafayette also has a vernier (69 cents) on page 291 of their '66 catalog. Using most verniers will restrict you to 180 degrees rotation, while the pot. will provide 270 degrees. The single pot. is quite adequate for AM work without the vernier, and is considerably cheaper. ...K9ALD

Report from the Board of Health

TVI traceable to 6 meters and channel 2 can be difficult and it takes a little time to get rid of it. Sometimes it is incurable. But, TVI caused by 10 meter radiation interfering with channel 2 is hardly ever difficult to control. A trap known as the half-wave filter is illustrated. The components specified allow its use with transmitters up to approximately 500 watts pep output and the capacitors are most susceptible; especially if vswr is above 1.5:1. The formula for calculating safe voltage ratings for the capacitors is: $C = \sqrt{2PxZ_0}$ where 2P is twice power output and Z_0 the transmission line impedance.

There are hams who are off the air because of TVI, and it is not necessary since the filter will provide at least 30 db attenuation for the attenuation for the second harmonic and greater attenuation for the third, etc.

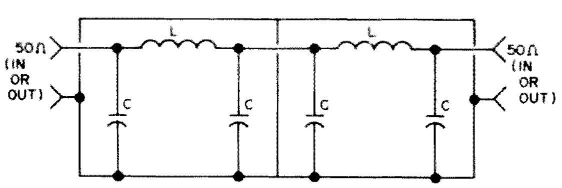


Fig. 1. A half wave filter for TVI.

Parts list:

C: 100 pf mica or ceramic "dogbone," 500 v–(up to 500 watt pep).

L: 5 turns 3/4" diameter self-supporting coil or tailor-made coil stock. Leave a partial turn for knifing to set desired center frequency with GDO; usually 28.6 mhz.

Box: 2¼"x2¼"x5" (more or less) with center partition. Make a small hole in the center partition for coupling the two sections, but don't use a feed-through by-pass.

Ray Stellhorn, WAØNEA

Official ARRL Bulletin 211

With the coming of the travel season amateurs will be taking advantage of reciprocal operating agreements. Amateurs traveling across the Canadian United States border should apply for an operating permit 30 to 40 days in advance. W/K licensees apply to the PO Dept., Century Bldg., Lisgar St., Ottawa, Canada, or its six regional offices. Canadians apply to the FCC, Washington, D.C. 20554. Travelers visiting elsewhere should allow at least two months for processing of requests. Write to ARRL HQ for details on a particular country.

Vernon Fitzpatrick WA8OIK
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Hancock, MI 49930

A VHF Band Scanner

The pan adapter has received a considerable amount of publicity and does a fine job for the HF (160-10 meters) ham. The pan adapter that covers 250 KHz is usually sufficient. The VHF ham, however, may want to observe 2 MHz or more of the band.

The band scanner to be described will cover the full 4 MHz of the 6 and 2 meter bands, if desired. The band scanner is sometimes referred to as a spectrum analyzer. Either term is ok but I prefer band scanner.

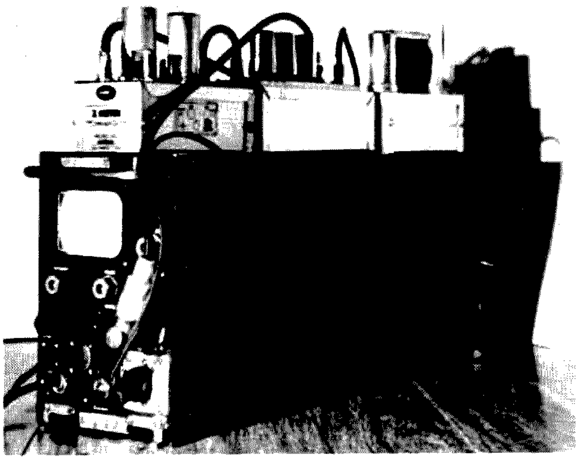
Pan Adapter vs Band Scanner

There is very little difference in the units. The pan adapter has the same input frequency as the *if* of the receiver and is usually connected to the receiver mixer plate. This arrangement keeps the received frequency centered on the shield of the cathode ray tube. The selectivity of the *rf* stages of the receiver reduce the signal strength of the signals either side of the center frequency. The pips, or displays, are progressively smaller as they are farther from the received frequency.

The band scanner uses a typical crystal controlled VHF converter with the same output frequency as the band scanner input. A two or three stage *if* amplifier is usually required between the converter and the band scanner to give a good distinct display of weak signals. An *rf* tap for the receiver can be made at the input or output of the *if* amplifier. The band scanner display is independent of the receiver tuning. If properly adjusted, the scanner will have nearly equal sensitivity over the entire band. The scanner cathode ray tube shield can be calibrated for direct frequency reading.

The Units

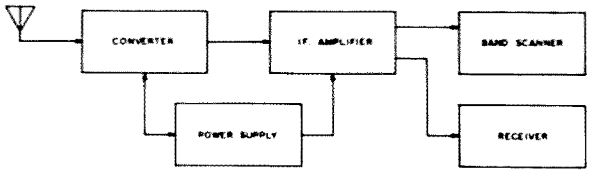
Band scanners are available on the surplus market so cheap that there is no advantage in constructing one. The scanner is easily repackaged to give it a neater and 'civilian' look, if desired. The conversion information



VHF band scanner. On top from front to rear are the converter, *if* amplifier and power supply.

that is sent with the IP 274/ALA10 or IP 69/ALA2 band scanner covers changing the power supply to 60 Hz (the original is 400 Hz) and changing the input to 14 MHz. All my VHF converters have 28-30 MHz output so I did not change the scanner input frequency. The IP 274/ALA10 and IP69/ALA2 scanners have the four standard oscilloscope controls: intensity, focus, horizontal position and vertical position. The scanner controls are; sweep limit, width, center frequency and gain. I removed the front panel power plug and replaced it with a plate and an ac outlet. The outlet is connected through the switch so the converter and *if* amplifier will be turned on and off with the scanner.

If you want to cover only 2 MHz of the band (I scan 144-146 MHz) the center frequency control may not center the scan. I use a converter output of 28-30 MHz so I injected a 29 MHz signal into the scanner input then turned the center frequency control to bring the pip as close to the center of the shield as possible. I backed the control



Block diagram of band scanner and associated equipment.

off about ¼ turn to allow for calibration then adjusted L 104 (scanner sweep frequency coil) to center the 29 MHz signal on the cathode ray tube shield. Touch up the scanner input and *if* coils for equal sensitivity at 28 and 30 MHz.

The converter can be constructed or purchased. Articles are readily available in past issues of *73* or the handbooks for those desiring to construct the converter. A poorly built converter can give false pips as the scanner will show any *rf* signal in the sweep range. The most common sources are self oscillation of a tube or transistor or excessive oscillator injection. Be sure your converter is adjusted for flat response over the sweep range.

I used a surplus 30 MHz *if* amplifier. If you prefer to construct your *if* amplifier *73* has a construction article on an integrated circuit 30 MHz amplifier on page 52 of the July, 1967 issue. Stagger tuning this amplifier should give it sufficient band pass and still have enough gain to operate the scanner. There are transistor and tube 14 and 30 MHz preamplifiers in the handbooks. These preamps will, of course, work as an *if* amplifier. The *if* amplifier requirements will depend, to a considerable extent, on the quality of the converter. The *if* amplifier should be tuned for flat response over the sweep range. Generally, an amplifier with 20-30 db gain is sufficient. The schematics show both capacitive and inductive coupling for the receiver *rf* tap at the *if* amplifier input and output. I use capacitive coupling at the output. If your receiver does not have an *rf* stage the local oscillator may radiate enough signal into the antenna input to give a false pip on the scanner. Connecting the receiver at the *if* amplifier output will minimize this condition. The receiver *rf* tap at the *if* amplifier input would be used by those that have a high quality receiver and the *if* amplifier would not aid the receiver.

Assembly

Due to the variations in the converters and *if* amplifiers that can be used with the scanner, and the simplicity of hookup, step by step instructions would be of little value. The interconnecting *rf* cables should be as short as possible. Use good VHF practice and no difficulty should be encountered.

Power supply requirements will depend on the units used.

Operation

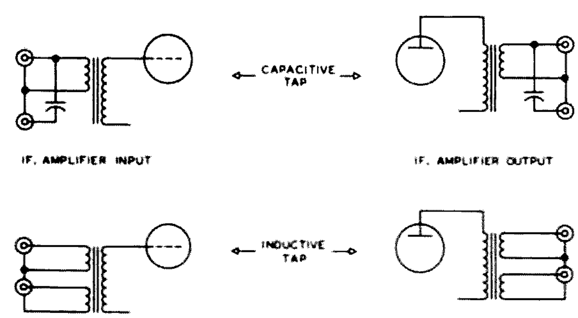
A band scanner will show the band activity, or lack of it, without tuning around and searching. The scanner can be used for analyzing signals as described in the panadapter articles. I find the scanner more convenient than my oscilloscope for aligning converters.

If you have more than one converter and antenna for a VHF band you may want to use separate converters for receiving and scanning. I use this system. The receiver coupled to the scanner lets me check out any other signals that I see without interfering with the QSO in progress. I put a relay in the scanner antenna lead and remove the converter B+ voltage when transmitting. The antennas are quite close together and the transmitter has a maximum output of 200 watts so I wanted to protect the converter from possible damage.

Some transmitters used in our local two meter net are crystal controlled and slightly off frequency so we have to tune for them. The scanner lets me see when they are on without wasting time tuning between transmissions to see if they are on.

Other Uses

For our CB friends who might be interested in a band scanner I would recommend a good *if* amplifier as no converter is needed. If, however, you plan to build a fancy scanner and calibrate the shield to show the



For capacitive tap use the smallest capacitor that will give adequate coupling. Start with about 20 pf and increase or decrease as required. For inductive tap make tap identical to the input or output winding and use minimum coupling. If input or output uses tapped coil use capacitive coupling. Some units may work better if band scanner and receiver tap are reversed.

channels, a converter is required. The converter will give you additional selectivity the same as a dual conversion receiver. Use a converter with a 14 MHz output and a 14 MHz *if* amplifier. There would probably be a small pip at 28 MHz from the converter oscillator. This would be out of the CB band so if you narrow the sweep to cover just the CB channels the pip would not show. Align the converter, *if* amplifier, and scanner for flat response over the sweep range as in the ham version. I would recommend a separate antenna. You might get enough isolation in the antenna relay so you could see your own signal when transmitting. I have not been able to do this with higher power.

Conclusion

Home brew construction of the converter and *if* amplifier is not recommended for the beginner as critical broad band alignment is required for satisfactory results. The band scanner has excellent broadband characteristics (max. 10 MHz) and alignment is not difficult if done carefully.

You will find a band scanner is an economical and fascinating piece of equipment for your VHF shack.

...WA8OIK

A Simple Inexpensive FM to AM Converter for Slow Scan TV and Facsimile

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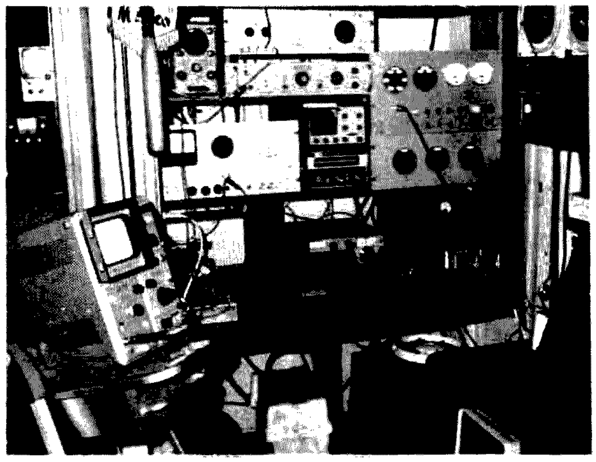
The heightened interest in slow scan TV and facsimile has brought forward a need for a converter to change the frequency shifted (FM) video or facsimile transmitted signal information into amplitude signals for feeding to a tape recorder, a slow scan TV monitor, a cathode ray oscilloscope (z axis modulated) with a photographing camera, or a facsimile machine. So far, the only available piece of gear appearing in surplus suitable for the above mentioned purposes has been the CV 172-172A/U, Frequency Shift Converter.

The CV 172-172A/U consists of the following elements, (Fig. 1):

1. Input
2. A band pass input filter
3. A limiter
4. Driver for the discriminator
5. A discriminator
6. A tuning indicator
7. A sound channel
8. Output

The tuning indicator, a dual "magic eye," defines the limits of the channel used, 800 cycle shift for black and white. The frequency limits in the CV 172 are 2300 (white) to 1500 cycles (black). A built-in monitor speaker is also included with the audio channel.

Analysis of the CV 172 reveals that many



View of satellite APT receiving equipment position: Tape recorder to right; FAX machine to far right; converter on right side of table.

of these elements can be dispensed with, since they are incorporated into a modern high selectivity receiver of the type used for SSB and RTTY. The irreducible minimum, then, consists of the input, limiter, driver, and discriminator (Fig. 2).

This simple converter is built from parts out of the junk box and uses two silicon diodes and one transistor (Fig. 3). In its quiescent state, it draws approximately 100 microamperes from the 9 V dc battery and approximately one milliampere under signal conditions. It would thus seem that the

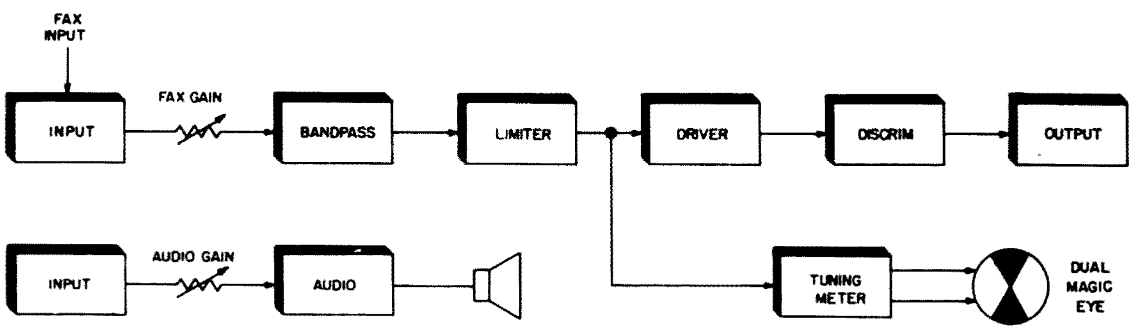


Fig. 1. Block diagram of CV172 showing all major elements.

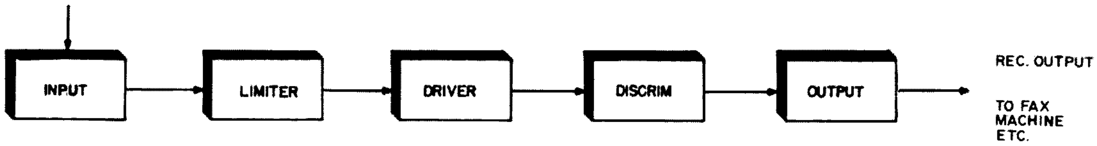


Fig. 2. Block diagram of absolute minimum components.

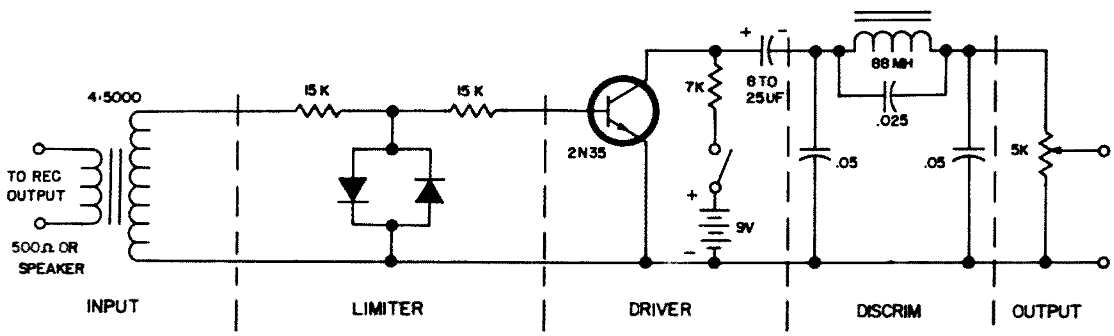


Fig. 3. Junk box converter using two diodes and one transistor.

switch incorporated into the unit might be an unnecessary luxury, since the life of the battery almost corresponds to its shelf life.

Any silicon diodes might be used, preferably those having similar characteristics. *Any* transistor may be used, NPN or PNP, with due care being taken to observe the polarity of the battery and the proper connections of the coupling electrolytic capacitor (**Figs.** 3 and 4). While this unit used one of the commonly available 88 mH surplus toroids, a horizontal width coil of the variable type, 45-215 mH (130 ohms), such as Stancor WC 14 or J. W. Miller type 6330 or 6324, might also be used. (All of the above parts were found in an old TV set, except for the silicon diodes, transistor, and 9 volt battery.)

The base (of 3/64 inch holed perforated metal) used was the cover for the horizontal deflection compartment of the TV set. 6-32 self-tapping screws lock in these holes nicely, (also from the TV set). The transformer used from the TV set was the speaker output wired backward 4 to 5000 ohms (estimated) and could be replaced by any transformer in the junk box having a good step-up ratio; even a 6.3 to 115 V filament transformer will work well.

In the author's particular case, being a RTTY enthusiast, and having full RTTY facilities, including a RTTY tuning indicator, the toroid of 88 mH frequency was tuned to 2975 Hz. When incorporated into the M derived low-pass filter used as a discriminator (**Fig.** 5), its frequency became slightly less than 2900 Hz. (If you wish to duplicate the CV 172, then more capacity is required across the trap inductance to tune to 2300 Hz.)

Connect the converter to the audio output of a receiver. Tune in a commercial RTTY station. As you tune through the RTTY signal (with bfo on), you will reach the point as seen on a scope (placed at the output of the unit), where only the mark or the space is left. The other one of the two signals will be sucked out or greatly attenuated by the tuned circuit trap of the discrim-

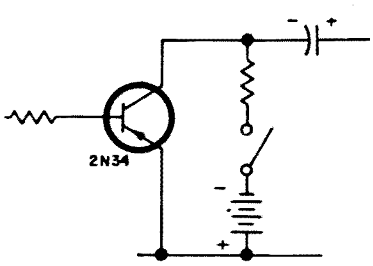


Fig. 4. Care must be used to observe battery polarity.

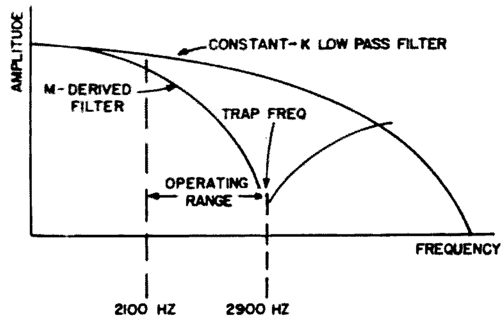


Fig. 5. Operating characteristics of discriminator.

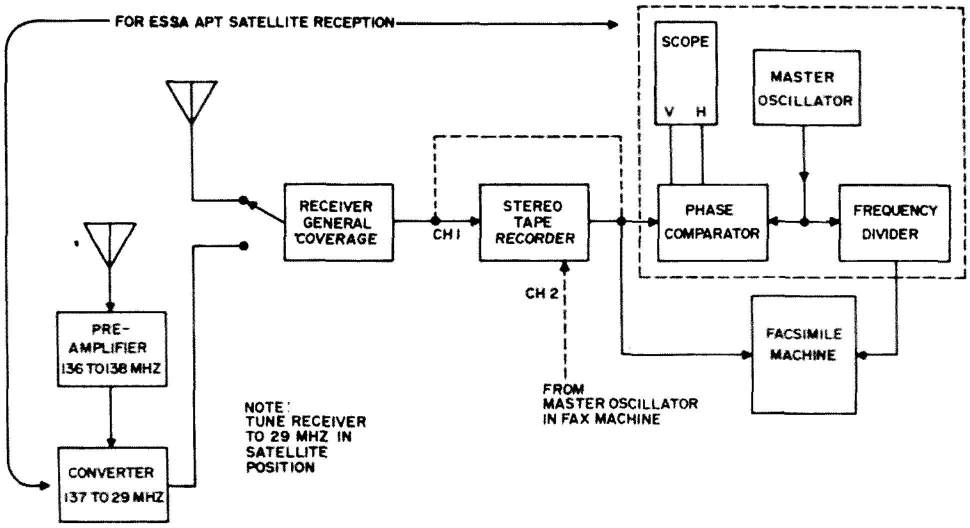


Fig. 5. Block diagram of the entire operating set-up.

inator. (Incidentally, this same converter, when combined with a rectifier and dc amplifier at the output, can be used to run a teletype machine.) The reason for using commercial RTTY signals is that they are far more numerous and easier to recognize, and their pulses are of longer duration than a station sending slow scan TV pictures or a weather map on facsimile.

When you have noted the correct positions of the tuning dial and the BFO for sucking out mark or space of the RTTY signal, you can then look for one of the reliable facsimile stations, such as Navy (NSS) on 3357, 4975, 8080, 10865, 16410, 20015 KCS or Air Force (KWAF) on 4502.5, 10185, 14550, and 19955 KCS (frequencies subject to change). These stations (when sending a picture) can be identified aurally by periodic tick-scratchings they make – like the sound of a phonograph record needle left running and repeating in the end-of-record groove of an *old* 78 RPM record with the volume turned up.

Often, when they are not sending fax pictures, they send "limit signals," one-half time black, one-half time white, at 800 Hz apart. These are ideal for tuning in the station. These limit signals are followed by phasing pulses, "ticks" only. They are then followed by a tone, then the picture. At the conclusion of the picture, another tone is sent.

The picture, as seen on the scope will be a series of pulses of audio at random times. (They will look like noise pulses.) Sweep of the scope should be set as slow as possible. If you are tuned to the wrong sideband of the signal, then you will see a kind of almost continuous signal with many dropouts. (This would give you a negative picture with white lines.) To reverse the situation, go over to the other sideband of the receiver and readjust the BFO. The tuning which gives you the cleanest baseline and maximum pulses is the correct one.

You will find this little converter every bit as satisfactory as the CV 172 and a lot cheaper! More fun too!

...W2BK

Confessions of an Appliance Operator

Or How to Ad Lib in Spite of the State of the Art

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Feasterville, Pa. 19047

Home-brew to me is what the XYL does with grapes. In fact, in my shack about the only home-brew addition is the junior op! This is not to cast doubt on the beauty of construction or testing. Nevertheless, because of the technical qualifications involved in "rolling your own" sophisticated electronic gear, I prefer to leave that excitement to members of the RCA net and those Ancient Modulation holdouts on 75. To me, the "stress interview" on 20 is much more enjoyable. Sadly enough, not enough hams feel comfortable when engaged in discussions other than those pertaining exclusively to their equipment.

I have often felt that such hams should be provided with a gentle guide to help them pump and drive their QSO's along – along lines that draw out the personalities hidden beneath the rubble of cliches and touch-and-go meaningless contacts which litter the ham bands. But this is not easy, for artificial guidelines restrict the natural blooming of the delicate flower or weed behind the mike. Be Maying like flowering is, why not try at least to offer a better and more fresh substitute than the dull weather report exchanges or information on the height of our antennas? This information may be important, but not as the sole nucleus of a QSO.

Each ham has his own specialized delight in amateur radio – curious as the specific choices may seem. Net operation and traffic handling for some, contests and county hunting for others, constructing and testing new antennas and home-brewing for still others. And then there is the hit-and-run DX man. Each interest is important and honorable, but without the personal touch ham radio can become dull and unprofitable as an exciting hobby. Without *personal interaction* and exchanging of cheek-tongued insults and information, viewpoints and prejudices, humor and confidences, sense and nonsense, we are not taking full advantage of the privilege we have open to us as licensed amateur radio operators.

Each amateur band ostensibly has a personality of its own. I, for example, have always considered 75 meters as tight and verbose and almost friendly; 40 meters is more open, but with copious quasiclosed Knights of the Roundtable; 20 meters is more brisk, because band conditions may change at the drop of a comment – thus necessitating economy of transmissions; 15 meters is generally considered a "DX" band, and it seems that more W's and K's call "CQ DX" on this band than all others (and it's amazing how often they succeed); 10 meters is volatile and especially sensitive to sunspots and low-power DX contacts. The remaining bands are not to be trusted. Especially by those of us who do not have the capabilities on 160, 6, and 2 meters. Moon-bouncers are an especially-especially seedy lot, and RTTY men should be placed under special observation. I refuse to mention those hams active in ATV!

But we return again to the old problem. Dull QSO's. Stereotyped. Mimeographed questions and planned answers. Let's rebel! Let's pin our next contact down and develop a line of conversation outside of that which might ordinarily be expected. Let's surprise him by being actually *interested* in where he lives, what he does to support his addiction to ham radio, what his opinion is on collecting dictionaries (only in English, of course!), how he feels about modern jazz in an oversexed society, what he considers the most important contribution the League has made in the last 50 years (QRX!), how he relates to the problem of the *skua* bird eating baby penguins (I learned that one from KC4USN), his etymological comment on why the 807 has been elevated from an electron valve to an edible-drinkable-item, et (basically) cetera. You get the point.

There are a lot a great guys hiding out

there behind mikes – let's try to draw them out. Let's find out what's happening – even on 75 meters! If the band stays open, let's not let them get away until we have had a meaningful exchange. And why not be more concerned about geography? Ham radio is the greatest "textbook" in the world, and most of us have never taken full advantage of it.

Although seemingly a contradiction in terms, reproduced below is a random sample – poorly developed – of the *Extra Top Quality Amateur Ad Lib Cheat Sheet.* The main idea is to be absurd but interesting. To spark something that virtually demands an answer – albeit a laugh or a groan. Like priming a pump, we may eventually put out-of-the-way remarks into the mouths of some of our more conversationally reticent ham buddies. At least we may make them QRT and thus clear the frequency for some hit-and-run DXers. We don't wish to encourage the "planned ad lib" – but let's at least attempt to emulate the open fun of our colleagues on that Grand Old Band – 75 meters. (And that's a lot of GOB, gang!)

1. What are you doing hiding out in a place like______?

2. If this vertical doesn't work out better, I'm going to melt it down and make a birdcage!

3. Your quad sounds fine; and it's great for drying sheets!

4. Your_______beam sounds great – if you don't mind a giant silver bird hovering over the roof!

5. Your audio sounds great – I didn't realize that mikes worked that well under water!

6. Don't worry about not getting out; your signal's probably healthy and clean, hiding out in Argentina.

7. I've always wanted to visit your state, but I could never get a visa (or: could never get clearance from the State Department).

8. Your quad sounds fine; they make great pelican roosts. But watch out for those 200-pound obese pelicans! The Department of the Interior frowns on this method of bird capture.

9. As the lumberjack said, see you a little later down the log.

10. I won't say the XYL here is against ham radio, but she did make me install the rig in a mobile home – forty miles away!

11. I own three SWR bridges – next month I'm buying an antenna to go with them.

12. I'm boning up for phone operation on 75 meters; I'm taking Caustic Remarks 305, followed by How to Squelch Breakers 103.

13. In order to get a QSO on 75, you have to be born there!

14. 75 meters is the St. Petersburg of the ham bands!

15. Did you hear about the robbery at the recent ham meeting in St. Petersburg? Someone stole 300 crutches!

16. Heard on 75: Your signal is weak here, OM. Only S9.

17. The roundtables on 40 meters are so involved and extensive that when one ham checked in, as a bachelor, he got married, his XYL had a son, and the son got his General in time to get into the QSO.

18. The QRM on 40 meters is very generous, politically – you have your choice of the Voice of America or Radio Moscow.

19. The rig here is a Kenmore washer, running about three horsepower into an aluminium clothesline up about five feet.

20. The antenna system here is 5,000 snails in cascade, fed by raw hamburger.

21. I won't say that I'm the epitome of Appliance Operators, but we *do* employ six First Phone men for general maintenance and equipment polishing.

22. I won't say the SWR here is unusually high, but it's true that the microphone radiates more than the antenna.

23. I realize that low angle of radiation can be desirable, but who told you to bury your antenna underground?

24. The antenna here is so high it was arrested by the narcotics squad.

25. I won't say the power here is low, but my nightlight draws more current than the rig.

26. Is it true that you have your DXCC certificate tatooed on your chest?

27. The antenna here is so low that it was knocked down by two angleworms playing leapfrog.

28. What are you doing playing ham, when it's obvious you'd be more qualified playing *bull*?

29. As Guy Lombardo said, see you around the band!

30. You should be pleased – just like the DX man who worked 43 countries in 26 minutes!

31. Yours is not to reason why; yours is just RTTY.

32. (Insert your best ad lib; Xerox; send to friends.)

And so it goes. The friendly fraternity of glib talkers. Truly interested in their fellow ham's scene and problems. Polished and poised, hesitant not to dash off the ultimate ad lib – duly practiced and recorded for tonal quality. Written and edited for punch. Eagerly awaiting the retort that stings, only to compose more clever spontaneous remarks at the next QSO. And, in spite of it all, perhaps something better will issue than the weather report or a detailed description of the antenna system. At least one would hope!

"I gotta keep an eye on him all the time or he's down at the radio shop spending money."

Household Helper In The Hamshack

A cleaning product known to housewifes as Scotch-Brite will find many uses in the hamshack. The exact parentage of this material is unknown to me, but it appears to be a form of plastic wool. It comes in several grades and sizes to fit the use to which it is put.

The homebrewer will find it excellent for cleaning printed circuit boards before soldering, polishing aluminum panels, and cleaning corrosion from antennas, ground rods, and the like.

I find the "ultra fine" grade to be the ideal filter for the blower on my linear. It not only catches the inevitable dust and lint, but also does a good job of silencing the noise of the air rushing into the intake. Try it! William P. Turner, WAØABI

Use of Frequency Charts

The selection of the optimum frequency is calculated from basic data published by ESSA, Boulder Colorado Research Center of the U.S. Government. The time is always in GMT, so 00 GMT is equal to 7 P.M. EST; 6 P.M. CST; and 5 P.M. PST; and so on across the chart. Due to our low power limitations we need to work as close to the maximum usable frequency as possible to reduce noise, so we bias the frequency selection toward the higher frequency bands when possible. During disturbances, try a lower frequency.

J. H. Nelson

What Am I Eating?

"King Sour Non-Butterfat Sour Dressing" made by American Whipped Products Company, Brooklyn. Alias ersatz sour cream. It is pretty good and you can hardly taste the quar gum.

PROPAGATION CHART

J. H. Nelson

June 1969

SUN	MON	TUES	WED	THUR	FRI	SAT
1	2	3	4	5	6	7
8	9	10	$\boxed{11}$	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	$\boxed{27}$	28
29	30					

Legend: Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7A	7	7	7A	14	14	14	14	14
ARGENTINA	21	21	21	14	14	7A	14	21	21	21	21	21
AUSTRALIA	14	14	14	14	7B	7	7A	7A	7B	7B	14	14
CANAL ZONE	21	21	14	14	7A	14	14	14	14	21	21	21
ENGLAND	14	14	7A	7A	7A	14	14	14	14A	14A	14	14
HAWAII	14	14	14	14	7A	7B	7B	14	14	14	14	14
INDIA	14	14	7A	7A	7A	14	14	14	14	14	14	14
JAPAN	14	14	14	14B	7B	7B	7B	14	14	14	14	14
MEXICO	14A	14A	14	14	7	7	14	14	14	14	14A	14A
PHILIPPINES	14	14	14	14B	7B	7B	7B	14B	14	14	14	14
PUERTO RICO	14	14	14	14	7	7	14	14	14	14	14	14A
SOUTH AFRICA	7B	7B	7B	14	14	14	14	14	21	21	14	14
U. S. S. R.	14	7A	7A	7A	7A	14	14	14	14	14	14	14
WEST COAST	14A	14A	14	14	7A	7	7A	14	14	14	14	14

CENTRAL UNITED STATES TO:

ALASKA	14	14	14	14	7A	7	7	7A	14	14	14	14
ARGENTINA	21	21	21	14	14	7	14	21	21	21	21	21
AUSTRALIA	21	21	14	14	14	14	14	14	7B	7B	14	21
CANAL ZONE	21	21	21	14	14	14	14	14	21	21	21A	21
ENGLAND	14	14	7A	7A	7A	7B	14	14	14	14	14	14
HAWAII	14A	21	14	14	14	14	7A	14	14	14	14	14
INDIA	14	14	14	14	7B	7B	7B	7A	14	14	14	14
JAPAN	14	14	14	14	14B	7B	7B	14B	14	14	14	14
MEXICO	14	14	14	14	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	14	14B	7B	14B	14B	14	14	14	14
PUERTO RICO	21	14	14	14	7	14	14	14	14	14	14A	14A
SOUTH AFRICA	7B	7B	7B	14	14B	14B	14	14	14	14	14	14
U. S. S. R.	7A	7A	7A	7A	7A	7	7A	14	14	14	14	14

WESTERN UNITED STATES TO:

ALASKA	14	14	14	14	7A	7	7	7	14	14	14	14
ARGENTINA	21	21A	21	14	14	7	14	21	21	21	21	21
AUSTRALIA	21A	21A	21A	21	21	14	14	14	7	7	14	21
CANAL ZONE	21	21	14	14	14	14	14	14	14	14	21	21
ENGLAND	14	14	7A	7A	7	7	7	7B	14	14	14	14
HAWAII	21A	21A	21	21	14	14	14	14	14	21	21	21
INDIA	14	14	14	14	14	7B	7B	7B	14	14	14	14
JAPAN	14	14	14	14	14	14	7B	14	14	14	14	14
MEXICO	14A	14	14	14	14	7A	7A	14	14	14	14	14A
PHILIPPINES	14	14	14A	14	14	14	14B	14B	14	14	14	14
PUERTO RICO	21	21	14	14	14	7	14	14	14	14	14	14
SOUTH AFRICA	7B	7B	7B	14	14B	7B	7B	14	14	14	14	14
U. S. S. R.	7A	7A	7A	7A	7A	7B	7A	14	14	14	14	14
EAST COAST	14A	14A	14	14	7A	7	7A	14	14	14	14	14

A - Next higher frequency may be useful this period.
B - Difficult circuit this period.

73 DX HAND-BOOK $3.00

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DID YOU RECEIVE your QSL information rubber stamp? Six Lines, 2½ inches wide. Please send $2.00 to get yours. Other Stamps—$1.00 a line. Large Call Letter Stamp, $1.00—John D. Kirke Co. (K8SRA) 17711 Lakewood Heights Blvd., Cleveland, OH 44107. (See Dec. 73 adv., Page 102) All Stamps Postpaid. Guaranteed Value.

SWAN 500C, mint condition with power supply. Going to school. Asking $500. Best offer takes. Contact WA3JLY, John Martin, 804 W. Broad St., Quakertown, Pa. 18951.

THE AUGUSTA (MAINE) Amateur Radio Club will hold their 10th annual Hamfest at the Calumet Club, Route 104, Augusta, On 15 June, preceeded with an open house and get together on Saturday evening the 14th at the same location.

SELL HEATH HR-10B, calibrator, used very little, just factory aligned, overhauled. Asking $85 or cash offer. John Linn, Jr., 24 Stuart Place, Manhasset, N.Y. 11030.

HAMFEST sponsored by Lancaster & Fairfield County ARC at Derby Downs one mile south of Lancaster, Ohio on BIS Road, Route 793, June 8th. Gigantic Swap Shop. $1 registration with prizes every half hour. Main prize drawing. Good food at reasonable prices.

FOR SALE—One K.W. custom built transmitter. Pair 100ths in final, modulated by pair of 805s in class "B." Built in two matching cabinets measuring 40" wide, 68" high and 21" deep. Has 13 meters. Sacrifice $195. Hubert Ingalls, W1NQ, McCrillis Road, Nottingham, N.H. Tel. Epping 679-8862.

2-WAY MOBILE TECHNICIAN by S. Florida 2-way service corporation established 25 years. No beginners pleasel Minimum 5 years experience required on Motorola and GE. Send full resume including salary requirements and snapshot to Spencer Communications, 440 25th St., West Palm Beach, Florida 33407.

NORTH ALABAMA HAMFEST will be held August 17, 1969, in the cafeteria of John C. Calhoun State Technical and Junior College located north of Decatur, Alabama, on U.S. Highway 31.

WANTED ANTIQUE RADIO and wireless equipment. Also radio magazines of teens and twenties. Also buying supply catalogs, Duck, Manhattan, etc. Farrell, 2252 Dixie, Pontiac, Michigan 48055.

FOR SALE back issues—Radio TV/Electronic World magazines: 1953-1968; $1.50 ea. special issues $2. A.C. Gary, 378 W. Palisade Ave., Englewood, N.J. 07631.

B&W 5100s, 51-SB/B SSB generator, together $175. HR-10 excellent, just realigned $50. Want Heath supplies HP-23 or HP-13. Don Falk, Burton Hall; Oberlin, Ohio 44074.

FOR SALE—R392/URR receiver-mobile version of R390/URR-excellent condition with manual and accessories—$400. Brock, 2226 E. 28th St., Brooklyn, N.Y. 11229.

AMATEUR RADIO CERTIFICATE: Display impressive 8½"x11" personally endorsed certificate in your shack. Send $1 to Amateur Radio Certificate, Box 244, Miami (Kendall Br.) Fla. 33156.

SELL: COLLINS 51J-4 in Superior condition with cabinet 6KC and 3KC mechanical filters. $800. Warren Amfahr, WØ WLR/5, 3100 Brookview, Piano, Texas 75074.

REGULATED POWER SUPPLY KITS, .6-4 amp, $2.75 to $8.50. Zeners, thermistors, 25¢. 10A Triac, $1.75. Diodes, 5¢. Nixie, $5. Decimal Counter Kits, $3.50. Catalog. Murphy, 204 Roslyn Ave., Carle Place, N.Y. 11514.

FILTER-CONDENSERS: Aerovox Oil Filled 100 mfd. @ 3000 vdc condensers. $30 each. Basil J. Weaver, 1821-C-Ave M, Lubbock, Texas 79401.

SELL: NEW 4CX1000A with socket. Jennings 10KV 500 pf vacuum variable capacitor; Simpson plate and grid current meters; 5700 VCT plate transformer, 175 pounds. Package price $125 FOB. Pictures available, $1 refunded on purchase. WA6-THG, 6279 Stow Canyon, Goleta, Calif. 93017.

WANTED: Military, commercial surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

HIGH VOLTAGE TRANSFORMERS wanted: Range 10,000 to 40,000 volts or higher. State voltage, current capabilities, and price. Bible, 409 Pennsylvania, Oak Ridge, Tennessee 37830.

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Here is a fine value for parts and a fine breadboard. Each computor board contains about 50 diodes in addition to transistors, high-quality, low-voltage electrolytic capacitors, trim parts and precision resistors. Components are easily removed and have long leads. Each board is different. The plug-in board makes a fine breadboard or component board. Dimensions: 16"x4"x1". Weight 1 lb.
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This system was made by Canadian Tire to sell for $35.00. These are Brand New fully wired surplus, not rejects. The extra high voltage coil provides smoother running at high speeds and longer plug life, and the lower current through the points makes for longer point life and faster winter starts. Special connector allows instant changeover to conventional ignition. Fully guaranteed, with instructions ready to install for 6 or 12 volt negative ground car. Closeout Special: DTI.......$10.00 P.P.

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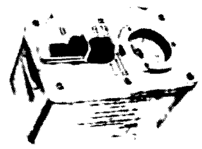

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SPECIAL ITEM SALE

VHF RECVR, Collins or Wilcox, 118-136 mhz, AM, 110 vac, makes first class net or monitor recvr, ex-FAA, was $125..........$60

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FREQ. METER, 10-100 mhz, similar to above instrument, rack mount, 115/230 volts with original calibration book and schematic, best quality made, was $495..........$250

PULSE GENERATOR, Measurements Corp type 79A, required for all digital circuit work, 115 vac, was $88.....$49

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NEED A VARIABLE CAPACITOR for that homebrew project? We may have what you need at more than 50% below regular amateur net. Send for free flyer. A.R.C. Sales, 181 E. Wilson Bridge Rd., Worthington, Ohio 43085.

3 PLASTIC HOLDERS will frame and protect 60 cards, $1—or 10 holders $3. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, Tennessee 37066.

SPECIAL CLOSE-OUT SALE. Rectifiers, Transistors, and many other Electronic Parts. Lowest prices. Send 15¢ for Catalog. Electronic Components Company, P.O.Box 2902 S., Baton Rouge, La.

FOURTH ANNUAL Mini-Hamfest, sponsored by the Rockford Amateur Radio Assn., August 17, 1969, at the Boone County Fairgrounds in Belvidere, Illinois. Lunch and refreshments.

SELL: HW-30, GR-64, Globe Chief 90-A, HG-10B. All good. $30 each. No manuals. You pay postage. WA3HWI, 7940 Gilbert Street, Phila., Pa. 19150.

WRL'S USED GEAR has trial-terms-guarantee! KWM1-$299.95; Swan 240-$179.95; TR3-$399.95; SB34-$319.95; Galaxy V-$229.95; Galaxy V Mk 2-$279.95; HX50-$199.95; Invader 200-$249.95; Galaxy 2000 plus linear-$329.95; Ameco R5—$59.95; HR20-$79.95. Hundreds more. Free "blue-book." WRL, Box 919, Council Bluffs, Iowa 51501.

HT-32A and TURNER MIC, $225, 75A4 #3234, 3 filters, 312A1 station control with Patch, $450, Hq-129X and spkr $90; TS-382 A/U osc. $125; Eico 667 checker, mint. $80; all items exc. cond. Also misc. parts and test eqpt. SSAE for list, W5LA, 1725 Valmont St., New Orleans, La. 70115.

B&W 5100-B Transmitter for sale. Best offer. Excellent condition. Contact Central Amateur Radio Association, 15 Centerville Road, Warwick, Rhode Island 02886.

ATTENTION CANADIAN AND NEW ENGLAND HAMS! The annual convention sponsored by Radio Amateur of Quebec Inc. will be held in Granby, Quebec, on the 27, 28 and 29th of June. Information and advanced registration from VE2BLP, Box 523, Granby, Quebec.

WANTED HRO COILS—all bands—any year for 5-7 or 50. Also want an HRO 5 for spare parts. Name your price. Wells Chapin, W8GI, 2775 Seminole Road, Ann Arbor, Michigan 48104.

FOR SALE: Hallicrafter SR150 ACps $350; Pr 4x150 Linear ps $50; Heath 10-12 Oscilloscope EF2 text and chassis $85; switches meters antennas etc., reasonable offers accepted. Geo. Shoner next to Library, Dugger, Indiana, 5 miles from US 41 on Ind. 54.

SBE 33 CLEAN never used mobile—$160. Walt Williams, 1706 Parkridge Terrace, Arlington, Texas. 817-261-9653.

THE EAST COAST VHF Society will operate station WA2WEB/1 on 432 mhz from Mt. Equinox, Vermont on June 21 and 22, 1969. The express purpose of the expedition is to provide amateurs on the East Coast of the United States with the opportunity of contacting the state of Vermont on 432 mhz.

The station will be on the air for approximately 24 hours for scheduled and non-scheduled contacts. Schedules are requested from interested amateurs. Write: East Coast VHF Society, P.O.Box 1263, Paterson, N.J. 07509. All correspondence and schedules will be confirmed prior to expedition.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 mhy torroids 5 for $2.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

WANTED: SCHEMATICS & instruction manual for Farnsworth model 600A camera & control monitor. Contact G.D.Petrizze, 2135 N. Allen Ave., Althadena, California 91001.

"TOWER HEADQUARTERS!" 11 Brands! Heights aluminum 35% off! Strato Crank-ups-low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog-20¢ postage. Brownville Sales Co. Stanley, Wisconsin 54768.

FOR SALE: HW32A in excellent condition, $89. with rugged homebrew power supply, $99.00. WA1IRU, Art Karis, 14 Caldwell St., Fitchburg, Mass. 01420 (617) 342-3469.

MINIATURE INVERTER Transformers, $5.50; Power your old-fashioned Toob Projects. Convert 6/12 vdc to 100/250 v @ 100 ma, diagram supplied, W6PJN, Box 611, Clovis Calif. 93612.

SALE/TRADE—POWERSTAT, 7.5 amp, 120V; Super Pro Power Supply; 4 mf @ 1500 v oil conds; Ham-Scan HO-13; Heath Scope #10-21; Drake 1A; 51J1; BC342 and P/S; Hugh Burnham, K6VNU, 2866 Magnolia Avenue, Long Beach, Calif. 90806.

FOR SALE: Ht-37 100 watts and HT-41 1000 watts, both $375; Heath SB-300 rcvr, $175. Telephone 516-295-5411.

BACK ISSUES QST, CQ, 73 and Pop Elect., 75¢ ppd. Galaxy 300 xcvr/power supply, $125. A. Assenza, 82 Florence Aven., Arlington, Mass. 02174.

TOROIDS 88 OR 44 MHY unpotted. 5 for $1.50 ppd, continental USA. SASE for list of other bargains. M. Weinschenker, Box 353, Irwin, Pa. 15642

FOR SALE: Heath HW-32, HP-23, SB-600, Cal., cables, manuals, $135. SX-101A, $225. HT-37, $225. Extras. All excellent. WA2VWG, 6029 56th Drive, Maspeth, N.Y. 11378.

SELL: Clegg Venus 6 mtr. transceiver, ac supply, mint condition. Original cartons, $300. WA8ZUA, 7230 Wilmington Pk., Dayton, Ohio 45459.

THE PALMETTO AMATEUR RADIO Club announces its Second Annual Hamfest to be held indoors at the State Fair Grounds, Columbia, South Carolina, on June 1, 1969. A dutch supper is in the planning for the night before. The Hamfest will feature swapping, a transmitter building contest, homebrew contest, antique radio display, FM and MARS Forums, and bingo for the XYLs.

FOR SALE: 75A4, Vernier knob, noise blanker, .8 & 3.1 khz filters, external compression amplifier 200 hz filter. $350. GPR 90 rcvr xtal calibrator, outboard product detector, vernier knobs, Tapetone converter 50-54 mhz. $250. Tristao galv. tower 54', 10-15-20 Hygain beam, rotator, you dismantle. $150. Shipping and packing receivers not included. Carl Thorsell, 1195 E. 77th St., Kansas City, Mo. 64131.

FOR SALE: HRO-7 with xtal calibrator. It made DXCC for me. $50 local only. Virgil Talbott, W6GTE, Monterey Pk, Calif. AN8-8868.

39TH-ARRL WEST GULF Division Convention August 15, 16, & 17, Amarillo, Texas. For an ideal summertime weekend of ideas, fellowship, entertainment, fun (and maybe good luck) you can't miss at $10.50 for registration. W5WX Panhandle Amateur Radio Club, Box 5453, Amarillo, Texas 79107.

TEST EQUIPMENT WANTED: Any equipment made by Hewlett-Packard, Tektronix, General Radio, Stoddart, Measurements, Boonton. Also military types with URM- ( ), USM- ( ), TS- ( ), SG- ( ) and similar nomenclatures. Waveguide and coaxial components also needed. Please send accurate description of what you have to sell and its condition to Tucker Electronics Company, Box 1050, Garland, Texas 75040.

WORLD'S LARGEST INDEPENDENT HAM MAGAZINE

July 1969

75¢

AMATEUR RADIO 73

SPECIAL

VHF - DX - MOBILE
ANTENNA - RTTY
HUMOR
SLOW SCAN TV

ISSUE

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...de W2NSD/1

Wayne Green

Silent Keys

It seems passing strange to me that I have yet to hear of any sort of ham ghost story. Do hams who pass beyond suddenly give up the passion of a lifetime and find something better to do? It may be that there is something to this tale Dante passed along about hell and perhaps most of the DX'ers are there, hacking away with bent keys and crystals that won't oscillate. Their dial cables probably have a lot of slack too.

In all semi-seriousness, I wonder if any readers have had any hints from the next world about DX conditions there? Any ouija board communications? Automatic writing? Or even via a medium? I gather, after a lot of reading, that communications with the departed is rather well substantiated to all but the most closed of minds. The problem with getting through seems to be one of converting frequencies. . .time and again they try and explain to us that their "vibrations" are on a different wavelength than ours. Since this obviously is not electro-magnetic waves that are involved, we may just have a clue that there are other types of waves than electromagnetic.

Mediums seem to be people that are sensitive to the other frequencies. Converters. They usually are connected in, not without QRM and other noise, to a medium in the next world who acts as a second converter. The result can be a rather good circuit, but is frequently about like trying to work a YK long path on a weekend.

Merely being aware that there is a possibility of a spectrum other than our electromagnetic should be enough to get some experimenters working on the problem. I am not sure what we might do if we found out how to use a new spectrum. I suspect that it would tie in with telepathy, might well be instantaneous (which make wavelength hard to define) and spaceless (which is an obvious function of instantaneous). What do you think? Or would you rather not think about it?

Conversions of Commercial Equipment

In the past I have been somewhat reluctant to devote much space in 73 to detailed conversions of commercial equipments. The concept being that, no matter how fascinating the conversion, it would be of specific value to only a very small percentage of our readers. In cases where a conversion or modification would work with a number of different pieces of equipment we have gone right ahead and published the articles.

While this policy was good for the majority of our readers, it still had the drawback of withholding valuable information from others. Now I have a little scheme that may solve this problem. I propose to publish modification articles separately and make them available to those interested at a nominal price. The author would still be paid the regular price for his article. . .the readers who need information on their particular piece of equipment could get it. . .and we wouldn't have to fill up the pages of 73 with mods on commercial gear owned by 2% of our readers.

So, if you have worked out any interesting improvements on your gear, perhaps this is the time to sit down and write an article on it. Send in the complete schematic diagram with the article. While it is virtually impossible to print these in 73 because they take up too much room, we can easily include them in a modification booklet.

Proofing 73

Now and then an incautious reader has, in the past, offered to help us beat back the growing tide of small errors and typos in 73. Unfortunately we have never been far enough ahead to do anything as simple as that. Now that we are setting our own type right here in our own headquarters there is a glimmer of hope that we may someday have a few articles ready for publication more than one week before the presses start running.

If you would like to have a chance to look at some of our incredibly fabulous articles before publication and promise to read them, watching for obvious typos and unobvious author errors. . .and even downright mistakes. . .and return them at the next high tide, all done with the welfare of amateur radio in your heart (no pay, this means), then keep not your intentions a secret.

(continued on page 98)

Robert A. Manning, K1YSD
915 Washington Road
P.O. Box 66
West Rye, New Hampshire 03891

Confessions of an Appliance Operator

Thundering across the airways and reverberating from speaker cones throughout the length and breadth of "hamdom" has come, like the piercing wail of a cow with a stepped-on udder, yet another epithet with which to flail and degrade an ethnic group within the amateur radio fraternity, i.e., You! You! You! Unspeakable appliance operator, you!!!

By over-simplification, an appliance operator is one who does not build his own equipment. He allegedly has the intelligence of a mentally retarded and recently pole-axed ox, the energy of a three-toed tree sloth, thinks manual labor is a Spanish War hero, is as socially acceptable as a skunk-farming roto rooter man with an aversion to soap, deodorant and mouth wash (in fact, he supposedly possesses all the mandatory prerequisites for becoming one of Katy Winter's closest friends); and his family tree–always suspect–is believed to be something he's living *in* rather than descended *from!*

At this point, it is necessary to clarify what is and what is not an appliance operator. Those who build at least 60% of their equipment can be classified as "homebrew specialists" or "artisans", those who build 10% or less are "appliance operators." The in-betweeners, for the purpose of this article, don't count.

There is, however, one nebulous Tinker Toy group that assumes the aura of, and is tolerated by, the artisan. They, in turn, look down their noses at the pure appliance operator. These ersatz artisans, called Gahzinters or Gahzonters do, in fact, build their own equipment...Uh Huh! In KIT form! (Hell, I know a 75 year old li'l ole lady with arthritis, palsy, 60/60 vision who didn't know the difference between a soldering iron and the south end of a north-bound mule who assembled a 23" television kit–this hardly qualifies her as this year's nominee for the second lead in David Susskind's off-Broadway production of "Tom Swift and His Electronic Grandmother.")

The Gahzinter is theoretically superior to the appliance operator 'cause he really knows what goes on behind the front panel of his equipment. For instance, T1–the big

black whatsis–gahzonter the chassis, the little glass things gahzinter the little holes, then the chassis gahzinter the cabinet, the cabinet gahzonter the table and the plug gahzinter the wall socket! (Whoopee! electronic "silly putty.")

It must be obvious–even to the Gahzinter–from the title and tenor of this article that I am that most loathesome of all creatures, an appliance operator!

There are many reasons that a person follows the path of the appliance operator–lack of time–lack of interest–inaccessability of parts–ad infinitum–ad nauseum. My reasons are two-fold; I was born under an unlucky sign and am afflicted with the domino syndrome!

Astrologers tell us that there are only 12 signs of the Zodiac–a gross untruth: there is a 13th sign (Heinie, The Municorn). The name Heinie was selected as a tribute to two of the unluckiest Municorns of them all, Buster and Lotta Heinie(named by parents with a perverse sense of humor). Uncoordinated "Three Thumbed" Buster Heinie, so uncoordinated, he couldn't walk and whistle at the same time, and his twin sister, Lotta, a cross-eyed seamstress who couldn't mend straight; both came to untimely ends. Buster traveled to India to take up snake charming and, on his first solo mission, was assigned a "deaf" cobra. Lotta, out of remorse, became a street walker in Venice.

The symbol for the thirteenth sign, The Municorn (a cross between a large mule and a pygmy unicorn) was selected because it epitomizes a continuous exercise in futility.

The male Municorn (the Gaffer) retains its pygmy size and horn, while the female (the Frail) remains large and mule-like.

The Municorn, understandably, proved to be unprolific and soon became extinct. For each time the Gaffer approached the taller Frail, it was necessary to get a running start and launch himself into the air. (Now, the Gaffer, like the Koala bear, feeds exclusively on eucalyptus leaves and is in a constant state of inebriation–accompanied by the blind staggers which tended to limit the height and often times the direction of his hunger). Keeping in mind that the Gaffer retained the one single horn directly in the center of his forehead and his inability to gain the required altitude, it was not an uncommon sight to see a Frail–with a startled, open-mouthed, buldging eyeball pained-look on her face–vaulting high into the air or dangling uncertainly from the uppermost limb of an apple tree.

You can usually recognize a "Municorn" by the soldering iron burns on his fingers, the crazy-quilt outer skin of band-aids, the battery acid holes in his clothes, singed eyebrows from overfilling his Zippo, and the cauliflower ear he got when, trying to put a "gleem" in his xyl's eye (he goosed her while she was brushing her teeth and she damned near decapitated him with the bathroom dixiecup dispenser.

My second drawback, the domino syndrome, is a series of cataclysmic and destructive events set in motion by one single action which blossoms out in mathematical sequence inversely proportional to their desirability.

It can best be explained by an example. Let's say it snows: you haul out your snow blower and attack the mountains of snow, accidentally gulping up the aluminum driveway reflector which feeds through the chute with unbelievable force and, like some vindictive NIKE missile, imbeds itself in your newest $65 snow tire.

The tire, suddenly devoid of air, goes wham! The rear end goes plop! And the shock absorber goes snap! pffsst! clunk! Now, while you're watching these mechanical hi-jinx, you absent mindedly run the snow blower into your son's brand new Flexible Flyer, which he'd brought out just before the snow fell, transforming it immediately into basket weaving material, bend hell out of your impeller blades and send slivers into everything within a radius of 50 feet–including the omni-present goggle-eyed poodle.

Thence, in a fit of pique, you become, for the moment, an olympic hammer thrower and hurl your snow blower high into a fir tree, ripping down your phone lines in the process.

This, essentially, is the domino syndrome.

The hardest part, of course, is trying to explain–coherently–to the phone repairman (who, when coming up the drive has wonderingly observed the harpooned snow tire, the pile of sawdust, the twisted sled runners and your wall-eyed hedgehog-like poodle and is now peering at you with a jaundiced eye,

ready to burst into frenzied flight at your first suspicious move) exactly what snapped your phone line and precisely what your snow blower is doing, roaring away, in a fir tree 30 feet above the ground.

Not long ago, I was involved in a domino repair project that began, as they all do, innocently enough. I had discovered that with two TV's coupled together on the same antenna, the broadcast receivers in the upstairs bedrooms buzzed loudly. Investigation showed that a simple two-set coupler eliminated the problem. I screwed the coupler into a shingle and, as usual, ended up needing about two inches of extra twin line. I gave a slight tug—just enough to not only pull down the twin line, but the antenna and a cleverly secreted hornets nest, complete with its irate inhabitants!

Later, after disengaging myself from the aluminum monstrosity, hiking back from the tar pit where I'd gone to escape the now homeless hornets and applying unguentine to the now-swelling stings, I climbed the roof and successfully re-installed the antenna. Unfortunately, on the way down, I slipped and clutched at the rain gutter for support. One end let go and I swung, pendulum fashion, back and forth past the kitchen window where my xyl was conducting a suburbian covin—a koffee klotch—with a local Gossiporter (Gossip/Reporter). (A Gossiporter—there's one in every neighborhood—is the end product of careful selective breeding during which the brain is completely disconnected from any thought processes and left to control only the dynamics for muscular activity. Since the brain no longer functions, the eyes and ears are left to absorb bits and pieces of information seen through curtained windows, heard over the back fence, or just imagined. These bits and pieces are assembled at a central point which I sincerely suspect is located slightly below the bottom-most verterbrae in that portion of the female Gossiporter's anatomy which looks the most ridiculous in slacks or shorts. There, it is embellished, distorted and transmitted to the tongue—a perpetual motion muscle—which oscillates at a fantastic rate of speed and in a screech that will peel paint, break glass and give every dog in the county an earache!

As I swung back and forth loudly scream-

ing for aid and assistance, I heard the scorched tongue visitor exclaim, "Good Lord! there's a huge bumpy faced 'ape' swinging outside your window!" To this, my xyl replied, "Don't pay any attention. That's my husband, the Dingbat! Yesterday he was playing Lloyd Bridges in the septic tank and today, apparently, he's Tarzan!"

The other end of the rain gutter finally let go and I sailed in a beautiful arc and was unceremoniously deposited into our utility trailer which, predictably, was filled to overflowing with a week's greasy garbage, a number of dust-filled vacuum cleaner bags and several shovelfulls of rabbit droppings from our pet rabbit (my children, little sadists that they are, they take after their mother, call the rabbit droppings, "fat raisins)."

Now, I've heard of being tarred and feathered for some heinous crime, but to be unguentined, garbage-greased, dusted and rabbit raisined should be reserved as a Rettysnitch for failing to prostrate oneself in the direction of Newington, Connecticut, during the 2100 broadcast, omitting a genuflection at the mere mention of the Newington deity—the spark gap—or for using Wouff Hong's name in vain. (Incidently, I understand that the National Simian Society is also located at Newington, Connecticut—there must be some moral significance in that fact somewhere!)

Naturally, I had an audience that burst into immediate and uncontrollable, hysterical laughter, claiming that, as I climbed out of the utility trailer, I looked not unlike a giant animated, slightly fuzzy and extremely malodorous toll house cookie.

To make a long story short, after de-raisining myself, I finally managed to remove the buzz from the broadcast receivers, but not before I'd discovered that the holes I'd drilled in the shingle were letting rainwater into the cellar and managed to drop the largest of the AM receivers on my foot.

Sitting, ankle-deep in rainwater, repairing the AM receiver was the project I was involved in when I first heard the phrase, "appliance operator!"

I'd just finished one of my better solder joints—slightly under an ounce of solder on the terminal board. Hearing the phrase appliance operator caused me to pop a diode and solder both my wedding ring and Timex watch to the B plus.

In an attempt to loosen the ring and watch, I overheated the connection, spoiling my solder joint, and accidentally slid my right thumb down the soldering iron, burning the thumb, my ring finger, left wrist and splattered boiling solder into the most inappropriate spot in my lap - yeah! in fact, it went right through the button holes—talk about lead in your pencil...wheee!!!

I screamed and leaped to my feet—the AM receiver still attached to my left wrist. I was sucking on my burned right thumb, trying to extinguish the fire and shake loose that damned AM chassis when I noticed my father-in-law poke his head into the shack. He looked at me sadly and shook his head and, turning to my xyl, said, "Daughter, please don't look in there—puulleease!!!—the damn fool is hopping around like a 230-pound sea numph, doing what appears to be a semi-lunar fertility rites dance, waving a radio over his head with his left hand and alternately sucking on his right thumb like a middle-aged male counterpart of Lolita and whomping himself on the lower abdomen—or crotch—which, believe it or not, appears to be on fire! If that clot-headed wahoo ever starts fanning with the other hand, he's gonna start riding side-saddle, need a transplant, sound like Wayne Newton and you'll be able to hear the 'top forty records' booming out of his navel. It wouldn't surprise me if the jerk yelled, 'Shazzam!' and leaped out the window!"

All this happened one evening at—for the ham: 2130 local—for the swl: 9:30 p.m. and for any Citizen Bander who may be having this read to him, that's when the little hand is on the 9 and the big hand is on the 6 and it's dark outside.

For what they're worth, these are my reasons for being an appliance operator.

In order to co-exist in the Artisan/Gahzinter world of amateur radio it has become necessary to devise a two-phase system to make it appear that I am a non-appliance operator. I've listed them here in the hope that they may help others in the same predicament.

Phase 1 (Making your shack look non-appliance operator). Assemble the following:

a. 1 ea. ½" wire brush to remove all the factory paint and lettering and give your equipment that "Spirit of St. Louis" look.

b. 1 ea. Dymo labeller to relabel all the lettering you just wire brushed off. (A magic marker is optional for the purist). Be sure to over-label everything—a light switch should read, "Switch," "Lights," "On-Off," "Up and Down."

c. 1 ea. pop rivet gun (remove all factory permanent screws, nuts and bolts and replace with pop rivets).

d. 1 ea. pkg of slightly rusted machine screws for replacing non-permanent fasteners.

e. 1 ea. package of assorted knobs, no two alike in size, shape or color.

f. 1 ea. can of spray crinkle paint complete with "paste on" paint runs.

Points to remember for Phase 1:

a. Always have a chassis or two laid out on the bench with a Sams photo-fax laying beside it.

b. Maintain a number of suspicious looking wires dangling from various and sundry places—give the impression that one false move by the visitor will instantaneously turn him into an unrecognizable cinder or arc weld him to the thunder jug in the corner.

Phase 2 (Second, but by far the most important, in co-existance is sounding like a non-appliance operator.

1. Break in on a net or round table at the most inopportune time to ask how your signal sounds since you substituted 8298A's for 6DQ6's in your final. If someone should fall into the trap and ask what an 8298A is, you can assume a pompous self-righteous air and inform him that to a dummy, that's a 6146B.

2. Be sure to be always looking for some obscure item—perhaps a transformer with one secondary of 5,000 volts, one at 7.3 volts and one at 1.9 volts—all at 2 amps or possibly a .007894 mfd electrolytic rated at 52 kvdc. One disadvantage to this is that you're liable to get some of this junk.

3. Be critical of all other signals. Make it sound as if you were carefully scrutinizing them on a scope (homebrew, of course). He's always drifting, flat-topping or pushing it a little too hard. (I had one fella give me a complete analytical observation of my signal. I later found out he was running mobile at 70 mph—half in the bag—and a hitch-hiker was tuning the rig.

4. During qso's, nets or roundtables, always miss a turn; then boom in explaining that you were just putting the finishing touches on your final stage.

5. If the other station is using a transceiver, keep coming up a little higher in frequency until you've reached the extremity of the band.

6. Become a specialist in some practically unknown subject, like the comparative value of aluminum waveguides as opposed to galvanized waveguides.

7. Become expert on one tube and its exact replacement. Be able to argue the nonexistant merits of each.

8. During qso's, slowly insert carrier into your SSB signal, or slowly reduce your output until someone brings it to your attention. Then correct it.

9. Install a toggle switch in your mike cord. By flicking it a few times during transmissions, you'll give the appearance of "breaking up."

10. When asked about your equipment, tell 'em it's home-made—home modified, altered and destandardized equipment.

11. Assemble a glossary of epithets concerning those "durned appliance operators."

12. So that you won't sound like a young whippersnapper, keep a memorobilia folder containing a list of old time operators, info on old radio shows, a sheet of "I remember when..." items.

Incidently, if you need any good unused ideas, let me know. I'm running a "going out of mind' sale...

Treat your fellow radio amateur as if he were someone special...he is!!

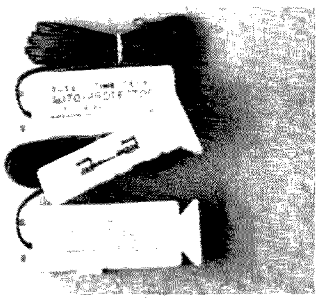
...K1YSD

MOVING?

Every day we get a handful of wrappers back from the post office with either a change of address on them or a note that the subscriber has moved and left no address. The magazines are thrown out and just the wrapper returned. Please don't expect us to send you another copy if you forget to let us know about your new address. And remember that in this day of the extra rapid computer it takes six weeks to make an address change instead of the few days it used to when we worked slowly and by hand.

New Auto Theft Protector

Do you live in an area where car theft is high? Are you afraid of going to a movie, only to come out and find your car and mobile equipment gone? If so, then try installing the Bussman Time-Delay Auto-Protector. (Bussman Mfg. Div., 2536 West University St., St. Louis, Mo. 63107).



The top protector has the activator arm removed to show ease of access in replacing fuses.

The heart of the protector is a time-delay fuse contained in a small hard plastic case. It's easily mounted in the glove compartment completely out of sight. The wiring is not tricky and connections are made between the thin ground wire leading from the distributor and coil (**Fig. 1**).

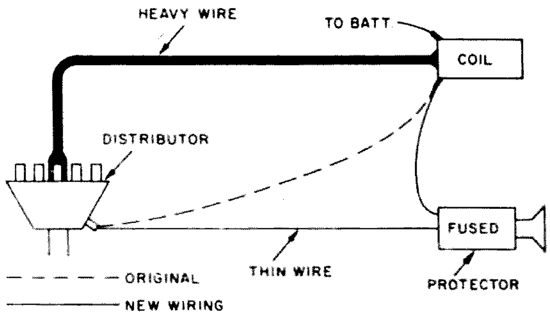


Fig. 1. Hookup of protector is very simple.

Anyone who tries to start the engine with the protector in the on position will find the engine quitting within one minute or less. When this happens, a thief is not going to take the time to look under the hood for problems, he's going to abandon the car. Remember, most thieves would rather drive your car to a safe spot before they strip it or try to take out your radio equipment.

The Auto-Protector sells for a little under $5 and can save you thousands in grief.

Robert N. Taylor, WA2SQZ

Clifford Klinert, WB6BIH
520 Division St.
National City, Calif. 92050

The Ancient Modulator

With the opening of new 160 meter frequencies and the tenacity of AM operators on VHF, a low power modulator can be quite handy in the shack of either a beginner or old timer. when a power supply and switching are included, it can provide power and control to any *rf* unit that is plugged into it. Let's take a look at this handy unit, and see how it was built.

Design

The first step toward bringing any project to life is to decide what is desired with respect to performance, and compare this with what is available. However, in this case, the parts in the junk box made the decision. Power transformers that would deliver 400 volts were there, and since 807's and 1625's were present in large numbers, the input of the rf amplifier would be limited to 40 watts, the plate current limitation of the tube at 100 milliamperes. This is still a very reasonable power level for vhf, and with the tubes and transformers operating at so conservative a level, long and dependable service could be expected.

Even with the low power required from the modulator, a pair of 1625's were used in push-pull as shown in **Fig. 1** T2, the modulation transformer, was a junk box item that does not exactly match the requirements. The required impedance is given by

$$Z = E/I = 400 \text{ volts}/0.1 \text{ amp} = 4{,}000 \text{ ohms}$$

So, it would be wise to consider this in the initial design. The unit used, however, had an impedance of 6,000 ohms, but no problems were encountered. The screen voltage was held at 300 volts by two voltage regulator tubes and the bias was provided by three nine volt transistor radio batteries in an attempt to run the modulators in class AB2. Again, these voltages are not exactly correct, but they are easily obtained and seem to work perfectly. A meter to measure the modulator plate current can be included, but it should not be considered as an accurate indication of the percentage of modulation.

The 6J5 was chosen to drive the 1625's because it was in the junk box. T1, the driver transformer, can be almost any single-plate to push-pull grids interstage audio transformer. The exact specifications of the one used are unknown. The one megohm gain control was placed in the grid of this stage as is customary to provide a good signal to noise ratio.

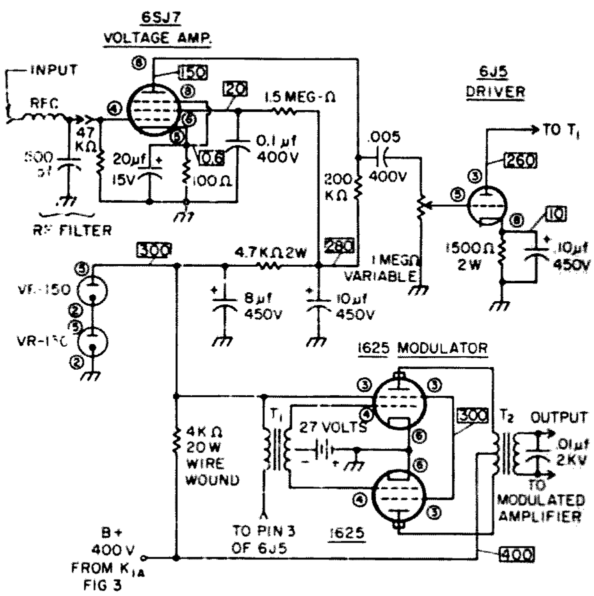


Fig.1. Modulator.

After a great deal of experimentation with twin triodes the 6SJ7 was finally chosen for the voltage amplifier first stage. It provides better than adequate gain from a single stage. The 47 K ohm resistor in the grid return of this stage was used to reduce rf feedback. It also reduces the gain of the stage considerably, but this was not a problem. A better solution would be a small rf choke in series with the grid lead, with a 500 pf capacitor from the grid to ground. RF

feedback may not be a problem on the lower bands, but it is sure to show up on the vhf bands as the howl that is so familiar.

Fig. 2 shows the power supplies, which require very little explanation. Again, components were selected for their reliability and availability. Two separate supplies were used to prevent the current variation of the modulators from causing a simultaneous drop in the voltage on the rf amplifier that would cause downward modulation. Two filament transformers were used to provide the twelve volts required for the 1625's and the six volts for the other tubes.

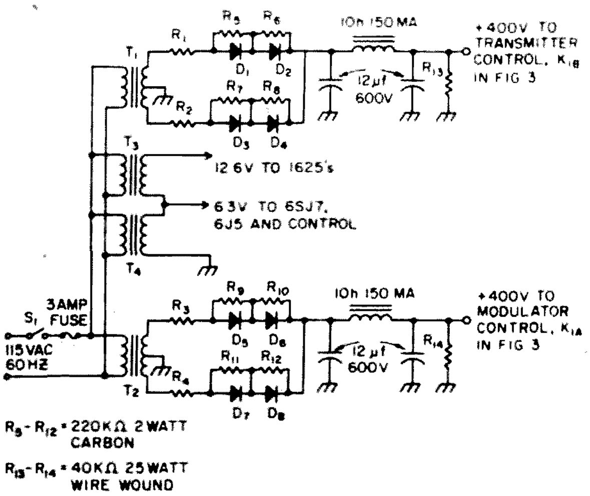


Fig.2. Power Supply.

The control circuit consists mainly of the relay and transformer shown in **Fig. 3** . T5 was used to provide isolation from the 115 vac line, and to provide six volts for indicator lamps. The isolation is necessary if one side of the microphone push-to-talk switch is to be grounded. The relay was used for rf switching as well as power and control switching. At vhf a coaxial switch would probably be desired for this application to provide low loss and shielding against feedback. The method used, however, was considered adequate considering cost and simplicity.

This is how it all started, now let's take a look at how it was built.

Construction

A standard 14 by 17 by 2 inch chassis was chosen along with the 19 by 8-3/4 inch rack panel and the side braces. They are all made by California Chassis. Handles were used on the panel because the unit is quite heavy. The layout and wiring are not critical except for the input audio stage, which should be carefully shielded to prevent hum and feedback.

If the relay is to be used for rf switching, the leads should be coaxial cables. In my case RG-58 was used.

Operation

The assembly can be tested one part at a time, first starting with the power supplies by measuring voltages, and proceeding through the amplifiers checking for output. Some typical voltages are shown in **Fig. 1** . These voltages were measured with a 20,000 ohm per volt vom, with all power applied and no load or audio signal. The final checks can be made with a suitable resistor or an output transformer connected to a speaker used for a load. Under no circumstances should the modulator be operated with no load. Even a small signal at the input can cause high voltages in the modulation transformer that can break down the insulation. Once the unit has been checked and is found to be operating satisfactorily, the output can be connected to the screen and plate of a suitable rf amplifier final stage.

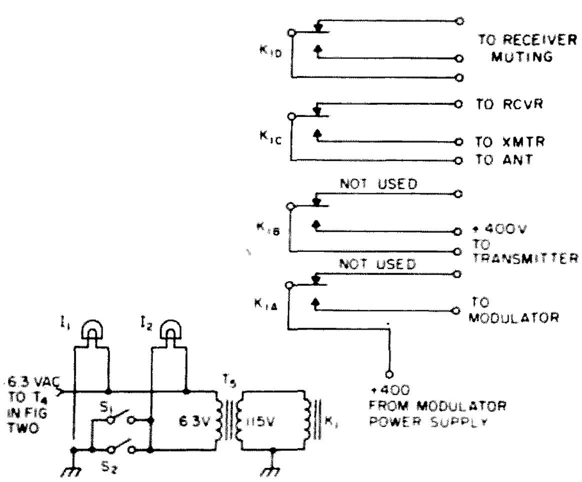


Fig.3. Control.

This unit has given excellent service and has been very dependable over a period of six months since the final version was put into service. The only failure was the result of a cold solder joint that had worked loose.

This modulator and power supply can become the basic starting point for a system made up of any number of low power *rf* units. Switching from one band to another can be accomplished by simply switching the filament power to each transmitter. The modulator could also be used in a more modest installation, as a part of a single transmitter. If this unit is used properly, it will give reliable and high quality performance in any system that its owner desires.

. . . WB6BIH

A Slow Scan Television Signal Generator

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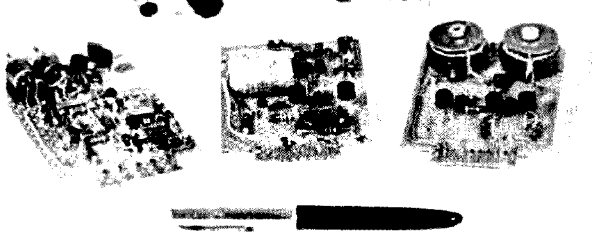
For a two year period (1967-1968) I was granted permission by the FCC to conduct experimental tests with other amateurs authorized for SSTV transmissions on the HF bands. This is a relatively new mode of communication and has only recently been made available for general amateur use. The interested amateur will soon find that he must construct his own SSTV equipment in order to enjoy this new mode of communication. The first item necessary for SSTV reception is a monitor. Details on the construction of an economical monitor may be found in 73 Magazine for July 1967. Once the budding SSTV enthusiast has completed construction of his monitor, he wonders how can he test it? What is needed is some type of signal generator that would generate the various signals required to check out the monitor. Signals of this type are generated by a SSTV Camera[1], or a SSTV Flying Spot Scanner[2]. In either case a lot of equipment is involved in generating a test signal. The unit described in this article has been developed to provide SSTV test signals.

Generator with Panadaptor



Three circuit boards that comprise the generator

1. "A Fast-Scan Vidicon In The Slow-Scan TV Camera." 73 Magazine.
2. "A Slow-Scan Television Picture Generator." 73 Magazine. Oct., 67.

Circuit Description

The SSTV Signal Generator provides selectable test signals of the Sync, Black and White Frequencies, a variable Grey Scale signal, a vertical Bar pattern and a variable Dot-Bar pattern. The sync signals are stabilized by synchronization with the 60 Hz power line frequency.

The transistors Q1 and Q2 are used to shape the 60 Hz power line frequency sine wave into a square wave so that it will stabilize the horizontal frequency miltivibrator (Q3 and Q4) at 15 Hz. The 8 second per cycle vertical oscillator (Q5 and Q6) is frequency stabilized by inter-connecting the horizontal oscillator through the IN-648 diode and the .047 coupling capacitor. Sync pulses are taken from the collectors of Q4 and Q6, combined and fed to the sync amplifier Q10 and modulator Q11. The vertical sync pulse is 30 ms long and the

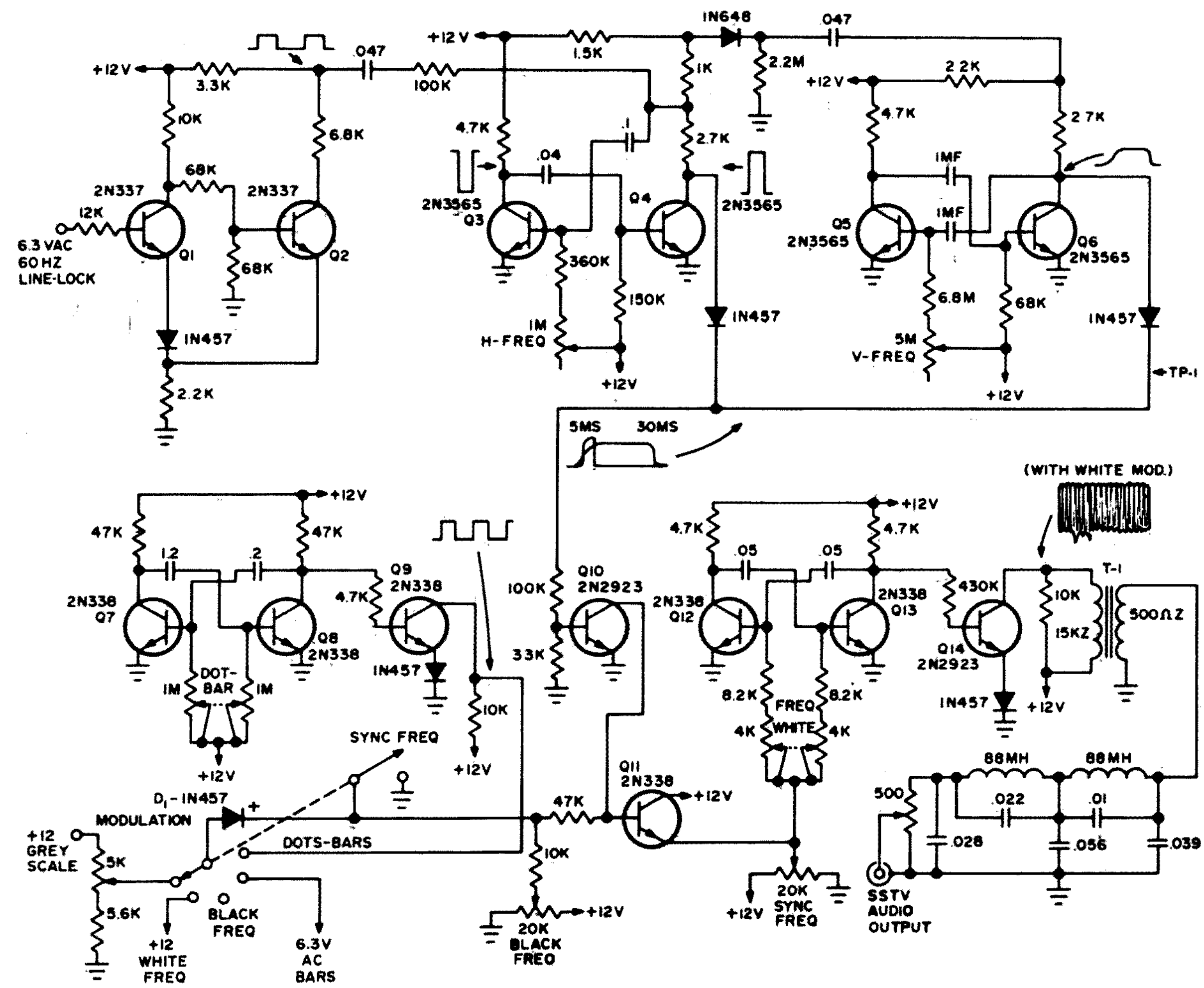


Fig.1. Schematic of SSTV signal generator.

horizontal sync pulse is 5 ms long. The Dot-Bar oscillator (Q7 and Q8) output frequency is manually adjustable from approximately 7 Hz to 80 Hz. This signal is amplified by Q9 and is connected to the Modulation Switch Dot-Bar position.

The 1500 Hz SSTV sub-carrier oscillator (Q12 and Q13) output is amplified by Q14 and is connected to the low pass filter through the step down transformer T1. The low pass filter rounds off the square wave output from the sub-carrier oscillator and attenuates any spurious frequencies generated above 3000 Hz. Positive going voltages appearing at the base of Q11 will shift the sub-carrier oscillator up in frequency and negative going voltages will shift it down in frequency.

The sync pulses from the sync oscillators are of the proper polarity when they appear at the base of Q11 to cause the 1500 Hz sub-carrier oscillator to shift to 1200 Hz for the duration of the sync pulse. The positive

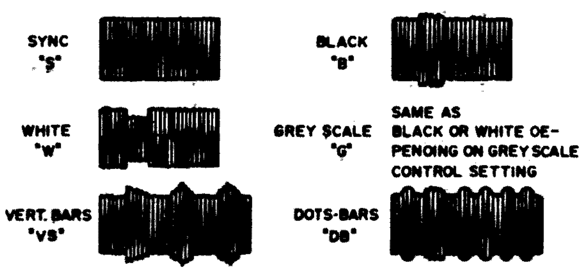
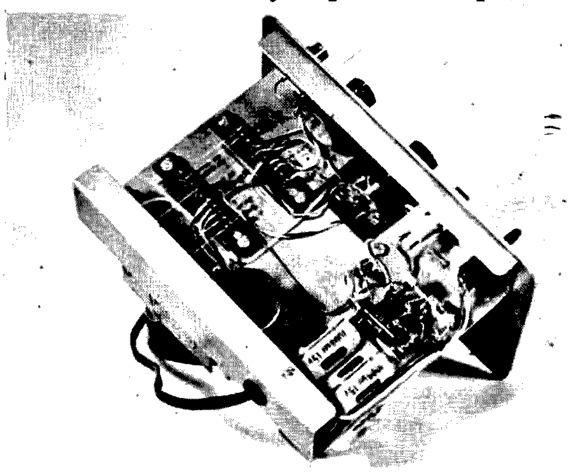


Fig.2. Oscilloscope patterns at audio output jack.



Bottom view of the generator.

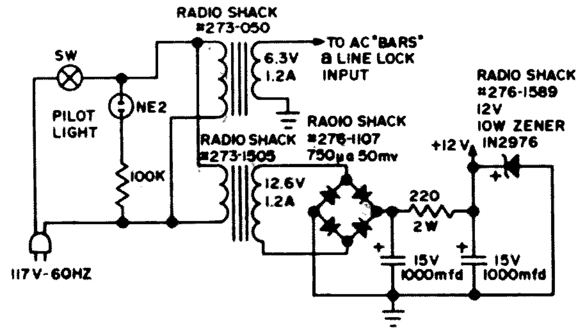


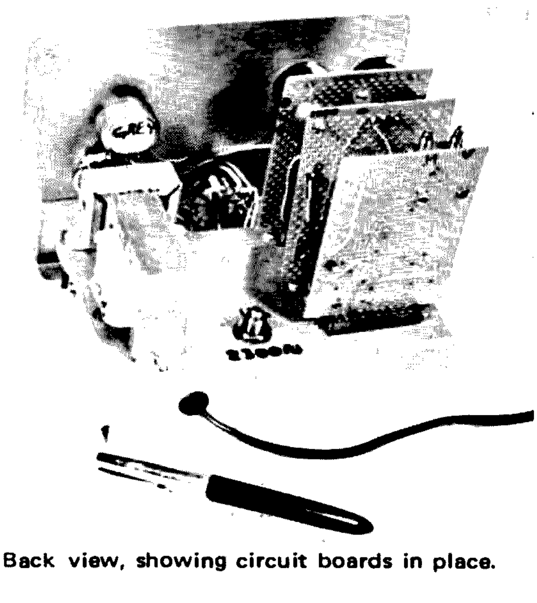
Fig.3. Power supply schematic.

12 volts from the "White" frequency position on the Modulation function control drives the sub-carrier oscillator from 1500 Hz to 2300 Hz. In the "Grey Scale" position, the voltage is manually adjusted from a positive 12 volts to near 0 volts which in turn shifts the sub-carrier oscillator to any frequency between 2300 Hz and 1500 Hz (White to Black).

Several fixed vertical bars are generated when the Modulation control switch is in the "Bar" position. The 60 Hz sine wave from the 6.3v filament transformer is rectified to a positive half wave by the IN457 diode (D1). This half wave dc voltage is used to modulate the sub-carrier oscillator thereby generating the desired stable vertical bar pattern.

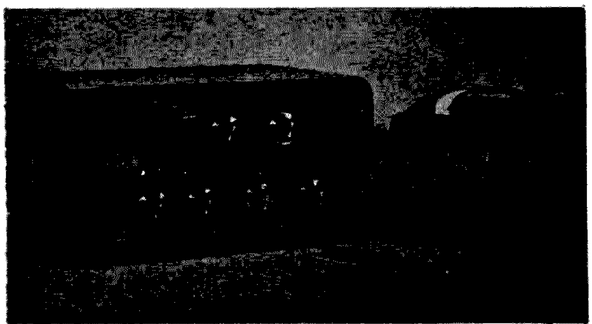
Construction

The major portion of the electronic circuitry is assembled on three plug-in perf-boards. One board contains the circuits for Q1 through Q6. The second contains the circuits for Q10 through Q14. The third board is used for the low pass filter and Q7 through Q9. The chassis is of hand-formed aluminum and is 5" D x 6½" W x 1½" H. The cabinet is 6" D x 8" W x 6" H. Point to



Back view, showing circuit boards in place.

point wiring was used throughout the unit. All resistors are of the ½ watt size unless noted otherwise. All transistors are of the NPN silicon type used for audio or switching applications. Many different types of NPN transistors were tried and all seemed to work satisfactorily in these non-critical circuits. The reader may probably note that some types used are old numbers, but that just happened to be the type left in my junk box.



Generator with Panadaptor

Adjustment

Connect a low capacity probe from an oscilloscope to the test point TP-1. With the scope sweep set to 15 Hz and the horizontal sweep sync at 60 Hz the signal generator horizontal frequency oscillator control should be adjusted for 15 Hz. There will be one 5 ms pulse appearing on the screen of the scope. The adjustment of the vertical sync pulse is more time consuming because of the long time lapse between pulses (8 seconds). Slowly adjust the vertical frequency control until the start of the vertical sync pulse coincides with the start of the horizontal sync pulse at each 8 second interval.

An audio frequency meter or audio digital frequency counter of the type described in 73 Magazine for November 1967 is connected to the SSTV Audio Output Jack. Preset the Black, White and Sync frequency controls to mid-rotation. Select "White" on the Modulation control and adjust the white frequency control to 2300 Hz. Then turn the Modulation control to "Black" and adjust the black frequency control to 1500 Hz. With the modulation control at "Sync" adjust the sync control to 1200 Hz. Repeat these adjustments several times as there is some interaction between the three controls. Typical oscilloscope patterns as observed at the SSTV Audio Output Jack are shown in accompanying diagrams.

. . .K7YZZ

William P. Turner, WAØABI
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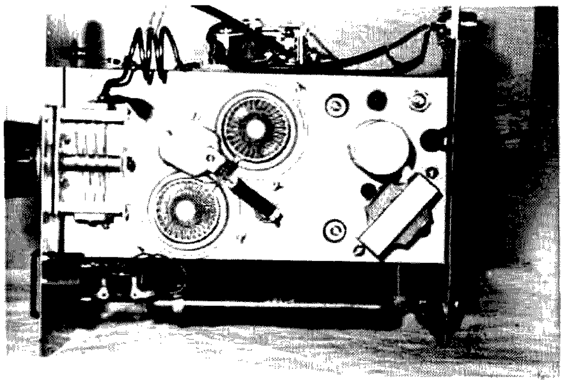
Saint Peters, Missouri 63376

A Six Meter Kilowatt Pep Linear For 10¢ a Watt



Top view of the amplifier. The resistor at the bottom of the picture is in series with the 100 CFM blower used to reduce air flow noise.

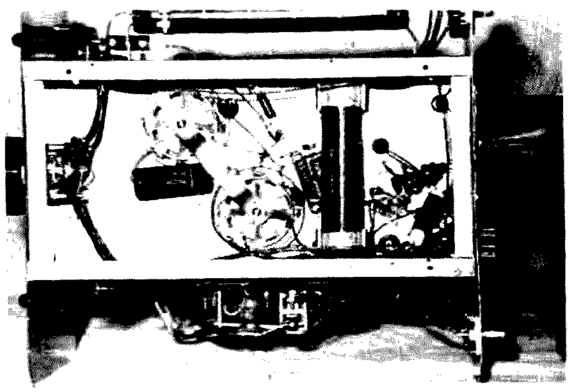
With the increasing sales of 6 meter SSB gear in kit and wired form and the sunspot cycle on the upswing, many hams are showing interest in running greater power in hopes of working long distance ground wave and international DX. This article will outline a simple, inexpensive kilowatt PEP linear and power supply. Quite frankly, the original amplifier was based on one described by K6QQN and W6QMN in the November 1961 issue of "73." The original has been rebuilt and modified several times during the past year. Three additional amplifiers of this type have been built, two more are under construction and several are in the talking stage. Performance has been outstanding, all have shown a signal increase on the order of 10 db and have been free of bugs. This power level was decided upon for several reasons. The tubes and transformers are readily available at reasonable prices, and the size and weight are in keeping with the state of the art.

Experience has shown that with careful shopping the complete unit can be built for less than $100, even if all parts are purchased. The average junkbox will make a dent in this figure. In fact, many parts may be salvaged from a TV if desired. All of the capacitors in the linear, the bias network resistors and potentiometer, low voltage·transformer and rectifiers, etc., may be obtained from this source at little or no cost.

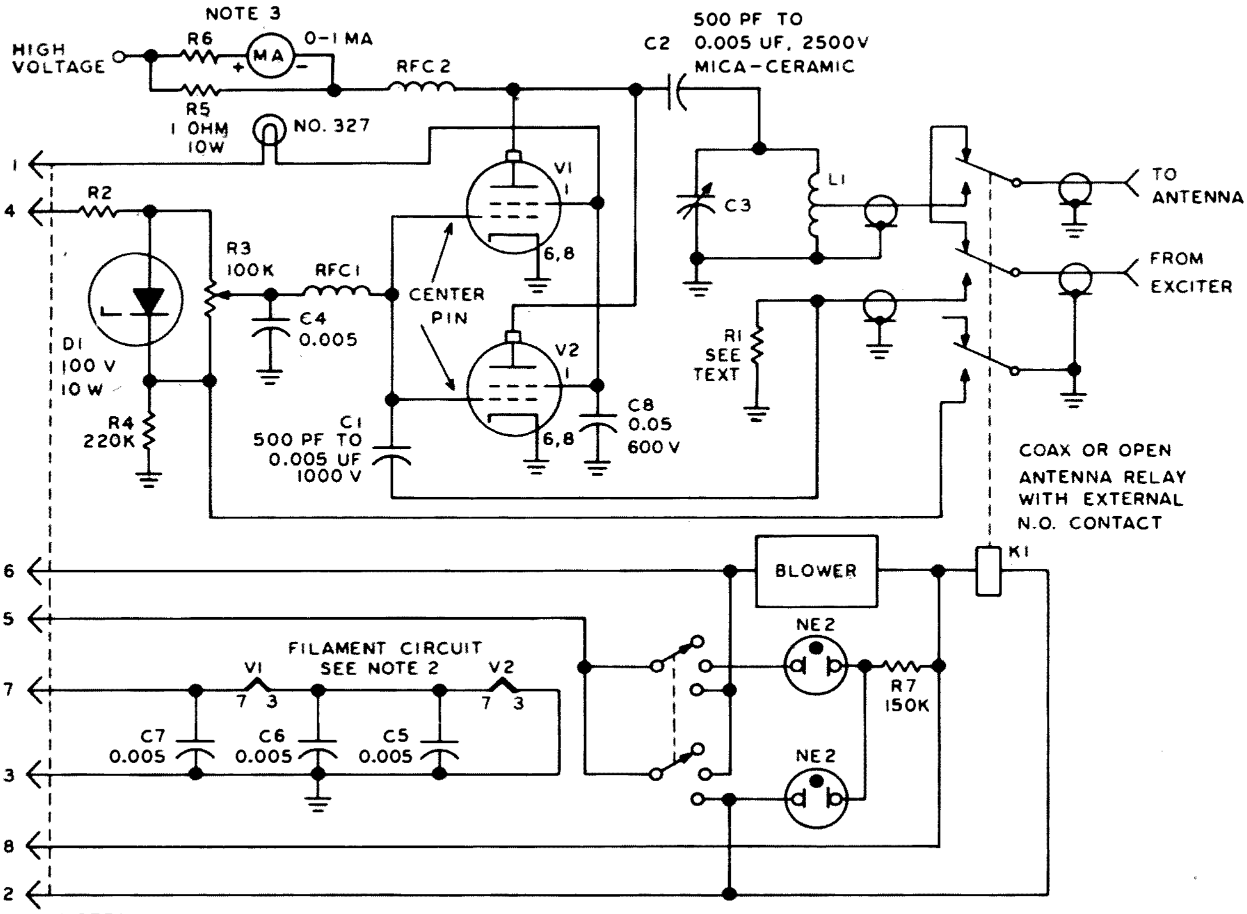
General Description

The linear consists of a pair of 4x150A/7034 or 4CX25OB tubes in parallel in a passive grid circuit. The plate voltage is 2000V, plate current is 500 ma peak.

The grid circuit load is dependent upon the amount of drive available. A 50 ohm, 50 watt Globar may be mounted internally for rigs in the 100 watt PEP output class or a Cantenna may be connected to the input through a coax "tee" connector. Much lower drive levels may be used by increasing the resistance at this point. A noninductive (carbon) resistor of sufficient wattage rating will allow the amplifier to be driven by five watts or less. The plate circuit is shunt fed through a home-brew or Ohmite Z-50 choke. Matching the load is accomplished by tapping down on the tank coil with a clip. Screen overcurrent protection is afforded by a #327 light bulb which acts both as an indicator of screen current and as a fuse.



Bottom view of the amplifier. The large cylinder is the load globar for the 100 watt PEP output of the exciter.



NOTES:
1. C3 = 25 TO 40 PF MAX, 3000 V.
2. C4—C7 = 600V CERAMIC. CONNECT C5—C7 DIRECTLY TO GROUND USING AS SHORT AS POSSIBLE LEADS.
3. R6 + RM = 1000 OHMS.
4. RFC1, RFC2 = 1-3/4" #28E ON 3/8" TEFLON, OR OHMITE Z-50
5. V1, V2 = 4X150A, 7034, ETC.

Fig. 1. The schematic for the six meter linear amplifier.

Purists may frown on some of the preceding, however there are good reasons for it. The passive grid circuit will accommodate any reasonable drive level and while wasteful at high levels it should be remembered that linears are for use only when required to maintain communication. It also eliminates neutralization as well as several parts. The shunt fed tank also makes for simpler, less expensive, and easier to adjust equipment. The bulb in the screen circuit functions as a protection relay and meter as well, but costs only a small fraction as much.

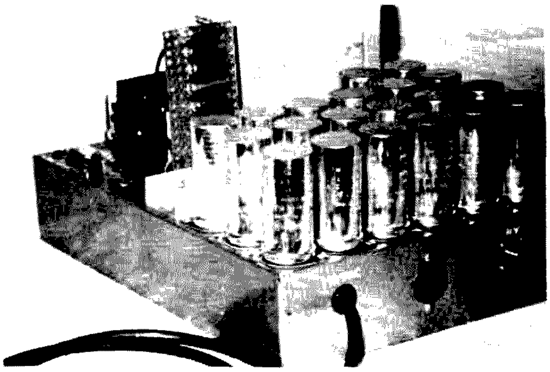
The screen power supply consists of a light to medium duty replacement or TV transformer, with full-wave rectifier and capacitor input filter. This supply is zener regulated at 300 to 350 volts. One half of the same winding is half-wave rectified and regulated (in the linear) at 100 volts negative for operating bias. The same supply furnishes cutoff bias in the receive condition. Filament voltage is obtained by phasing the 6.3 and 5 volt transformer windings in series. Slightly over 11.3 volts is available to the filaments which are also wired in series. This arrangement runs the finals at approximately 5% below their nominal 6.0 volts, which is within tolerance.*

The DC Supply

The high voltage transformer is rated at 850 to 1000 volts center tapped at 350 to 500 ma. Several power supplies have been built with a commercial surplus transformer available locally at $5.95. This transformer is rated at 1000 volts CT at 400 ma and provides 2200 volts at 450 ma in SSB service. Several nationally known supply houses list

*Ed. note: This voltage should be measured during normal operation to ensure that it stays inside tolerances.

usable transformers at $2.00 to $5.00. In some cases it may be necessary to series or parallel two transformers in order to arrive at the proper voltage or current rating. I would recommend a transformer of about 850 to 900 volts CT, otherwise the maximum voltage rating of the tube will be exceeded (this has been done without harm, however). Only the high voltage winding is used in order to increase the available current. Rectification is by eight 700 volt PIV silicon diodes in a voltage doubler and the filter consists of sixteen 40-40/450 volt capacitors in series-parallel. The total filter rating is 20 mf at 3600 volts. Twenty capacitors of the same type were purchased for $7.80 and used for all filtering purposes. The 10" x 14" x 3" chassis on which the power supply is mounted is not crowded. All bleeders are 13 K, 10 watt obtained at 20 for 59¢. Each bleeder section in the high voltage supply consists of two of these resistors in series. The remaining resistors are used in the bias and low voltage supplies.

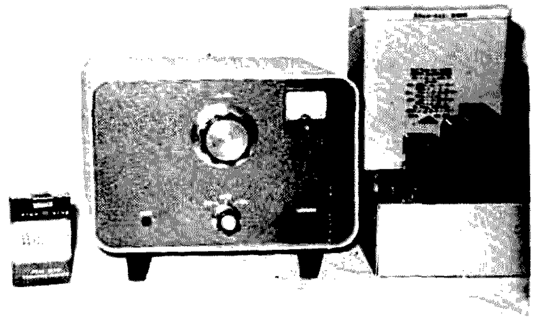


Power supply

Finishing Up

The controls are all on the amplifier and consist of a two pole, three position switch which turns on the 60 CFM blower and the filament, bias, and screen supplies in the "standby" position and also keys the high voltage primary relay in the "operate" position. This primary voltage is also fed to the antenna relay coil through the normally open contacts (spare) on the exciter PTT relay so that in "standby" it is possible to operate the exciter alone and in "operate" the linear is automatically switched into service. The only other panel control is the plate tuning capacitor. Neon lights indicate the position of the function switch. Inside controls adjust the bias in "operate" position and control the antenna loading. All of the control and low voltage wiring is contained within an 8 conductor cable: the high voltage lead is separate and consists of a length of RG-8U with PL-259 connectors which have been painted *red* to indicate their unusual function. Other connectors may be used if desired. Plate current metering consists of a 0-1 ma meter which with the proper multiplier indicates full scale when 1 ampere is drawn through a one ohm resistor which is in series with the high voltage lead.

The amplifier shown was built in a Heath



The amplifier matches the Heath SB series. It should be possible to use it on other bands by changing the tank circuit.

SB series speaker cabinet and fitted with Heath knobs in order to compliment an SB-110. A 10"x5"x3" chassis is supported within the case by the front and rear panels.

The panel was sprayed with Illbronze, "forest green" wrinkle paint, which is good for the Heath green. For Swan owners, I suggest the possibility of using a power supply cabinet. The above mentioned paint also comes in black.

Adjustment is simplicity itself. The exciter is tuned up per usual with the linear function switch in the "off" or "standby" position. The linear is then switched to "operate" and keyed momentarily while the bias control is adjusted to a static current reading of 200 ma. At this point a small amount of drive is applied and the plate tuning is peaked for maximum output as indicated by an SWR bridge in the forward mode or by using a monitor scope. Modulation is now applied until the plate current *peaks* at 500 ma. Some slight adjustment of the tank coil tap may be required at this time in order to load the amplifier properly.

The possibility of using commercial pull-out tubes should not be overlooked. These tubes are common in FM broadcast and aircraft ground station transmitters and as such are often changed on a time basis rather than on condition. They are available at hamfests and at surplus stores at nominal prices.

Amplifiers have been built with coax and

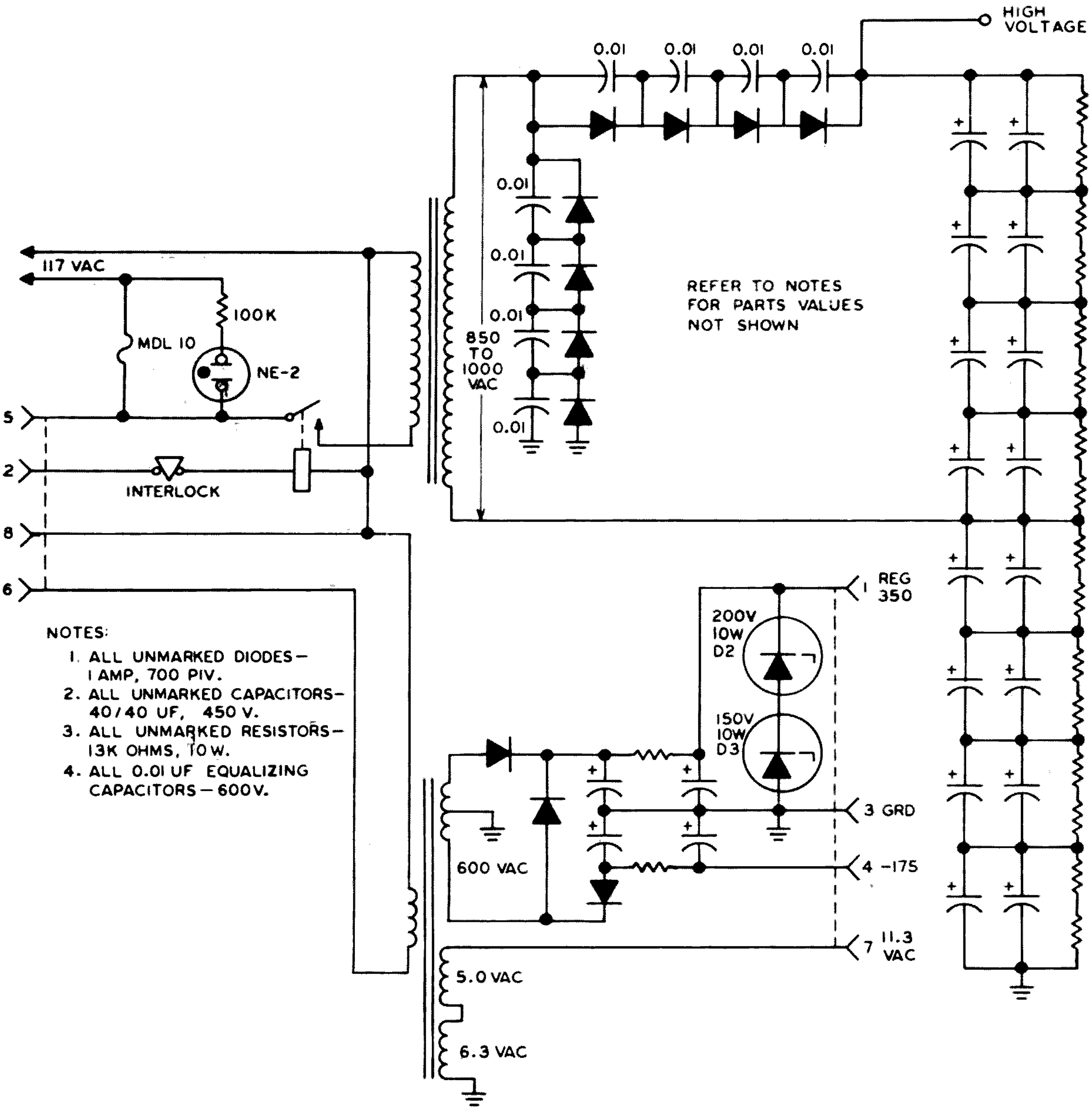


Fig. 2. Power supply diagram. See caution note at the end of the article.

open type antenna relays. The coax type have been found to be preferable; however, the open type will work quite well and will save the builder much cash.

For the sake of economy the blown fuse indicator and power supply cover interlock may be omitted. It is suggested that in the interest of safety the interlock be included.*

Most of the parts are of a highly non-critical nature. The input and output coupling capacitors have been varied from 500 pf to .005 without degrading performance. Various tuning capacitors have been used and all have worked well. The plate coil in each case was adjusted to resonate at 50 mhz with the capacitor fully meshed. Blowers from 30 to 100 CFM have been tried, the only undesirable effect noted was increased air flow noise above about 60 CFM.

The most critical item is the tube socket. *Do not use sockets without the built-in bypass* and do not leave out the external screen bypass.

...WAØABI

***Ed. note: I would suggest safe plastic covers for the large electrolytic capacitors at the top of the chassis. The interlock should *not* be eliminated under any circumstances, and do *not* depend on the bleeder resistor to drain the capacitor bank. Short *each one* before working on this rig. The amplifier is a good design, but could become a death trap for the uninitiated. If you haven't been burned yet, believe me, it isn't fun.**

A New Way to QSL

Ken Millar, ZE7JV
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When I first started out in Amateur Radio, it was a pleasure to send and receive QSL cards. Now, after nine years of operating, and a lot of contests behind me, there is no longer any pleasure in QSLing. Just a lot of work, and a large backlog of QSL's to catch up with. Like most other amateurs, I use a personal card, which has spaces at the appropriate places for filling in QSO information.

Some amateurs use cards which have all the necessary information ready printed, and, in order to save time and effort, check, ring, or strike out where necessary, but I have never adopted this method. I feel that it can lead to errors in vital information, unless great care is taken to check the correct item.

Some amateurs who QSL 100%, get into the routine of completing cards while still in QSO. This is a good system, but few of us are sufficiently methodical to keep it up, and when contest operating, it isn't practical to write out cards at the same time.

It seems, though, that present day practice is to QSL on receipt, unless, of course, the worked station's card is required, and the economy is justified—although the extra work and time spent looking through logs for previous months and years for a station's entry is considerable. What the active operator really needs, is an easy way of keeping up to date, but to take most of the work out of QSLing, a radical change is necessary.

While working on my backlog of QSLs, I thought about how the task could be simplified. I recalled that while operating in contests, log-keeping had been simplified by taking carbon copies, sending the original to the contest organizers, and keeping the carbon copy for my station records. I remembered, also, those "GE" cards which were so popular a few years ago, that used a small extract of an ARRL log book for the QSO information. It seemed to me that the way to simplify QSLing would be to use a method which would transfer the log information onto the QSL, with a minimum of effort.

If the logbook were made so that a strip of paper with the QSO information on it, it could be torn out and gummed to the QSL card, this would greatly reduce the amount of work required. The pages of the log book would be in duplicate, with a carbon in between—the upper page for the QSL, and the carbon for the actual log. The upper page need only be half the width of the log page, as the only writing on this portion would be the QSL information. Additional information, power input, time of ending QSO, remarks, etc. would be written directly onto the log page. The paper used for the QSL page could be gummed, or plain with gum applied by an applicator.

The QSL sheet does not need any printed wording on it, just the columns necessary, and perforations, although perforations are not absolutely necessary as a little practice with a pair of scissors, or razor blade and rule should soon make light work of it. The column headings in the ARRL logbook aren't quite suitable for this application, as the line spacing isn't sufficient for easy tearing. The strip should be about ½ inch deep to allow ease of handling.

Suggested column headings for the QSL sheet are: Date; Time; Station Worked; Freq.; Mode, 2-Way; Report.

All other columns appear on the log sheet. For contest operating, a second log sheet could be inserted, making a total of three copies, and it may be preferable to use loose-leaf pages, or a binder, rather than a bound logbook which cannot be varied at will.

The QSL card will need a slight modification. The column headings will be printed across the QSL, with sufficient space allowed below for the strip to be positioned without covering up other information. If the strip is made slightly narrower than the length of the card, it will be easier to place the strip in the correct alignment. A check should be made to insure that the card used for the QSL is suitable for a firm adhesion by the gum used.

The one disadvantage to this method of log-keeping and QSLing is the fact that more log pages will be used. An entry in the log will use about twice the space used in a current log, but the advantage gained more than outweighs this. A 100% QSLer using this, will just tear out the strips, gum them to his QSLs, and send them off. The "QSL on receipt" amateur can tear these strips out of his log as each page is completed, file or pigeonhole them in call-sign order; and as incoming cards are received, can quickly locate the cor-

rect strip without referring to his log at all. The contest operator has most to gain, as while actually operating, he can, at one fell swoop, complete his station record, contest logs, and QSL cards.

As I had a printing of QSL cards recently, I am unable to change over immediately, but I certainly will as soon as possible.

...ZE7JV

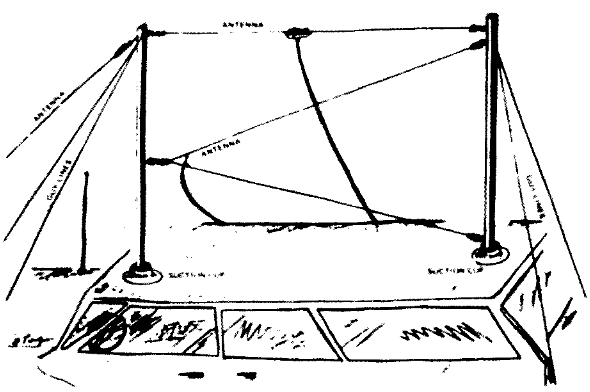
The Clothes Line

How often have you wanted a mobile antenna that could be assembled in minutes, costs pennies, adaptable to almost any band–then removable without a trace?

We needed such an antenna last winter. A friend and I had planned a trip to North Carolina for several weeks, but hadn't decided to take our rigs along until the last moment. Needing some sort of antenna, I stuck a large suction cup on the end of a five foot tomato stake and planted it on the roof of his station wagon. Four nylon lines were run from the corners of the front and rear bumpers as guy lines to hold the stake upright. A six meter dipole and a CB end-fed wire were attached from the top of this mast to two places on the hood of the car. Their coax feed lines went in thru a rolled down window.

So well did the "clothes line" antenna perform that a revised model was tried on a following journey. This time, two poles were used, giving better elevation and more efficient performance. For the mobileer who doesn't mind the way this set up looks, the wooden stakes become miniature towers that can hold any number of arrays. Ground planes, halo and whip types, even dipoles (which work surprisingly well on a moving car) are just a few of the antennas that can be suspended from the masts.

The next time you see a car with a clothes line on top, look again, it's someone operating mobile.



Larry Jack, WA3AQS

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Power Perk

432 MHZ Power Amplifier

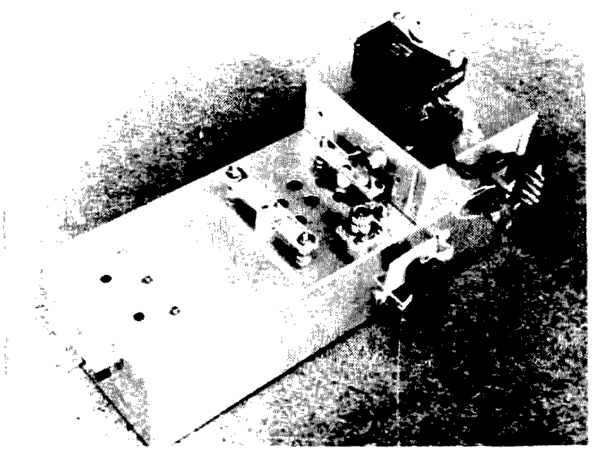
Here's an amplifier capable of running a full kilowatt on 432 mhz, without straining either the budget or the final tubes. The big difference between this amplifier and others that have been described, is the use of vapor phase cooling. This allows a relatively small tube to dissipate a lot of power.

Other features of this amplifier are:

1. Simple construction requiring no machine tools.
2. Single ended operation with no balancing problems.
3. Large overload capacity.
4. No noisy blowers.

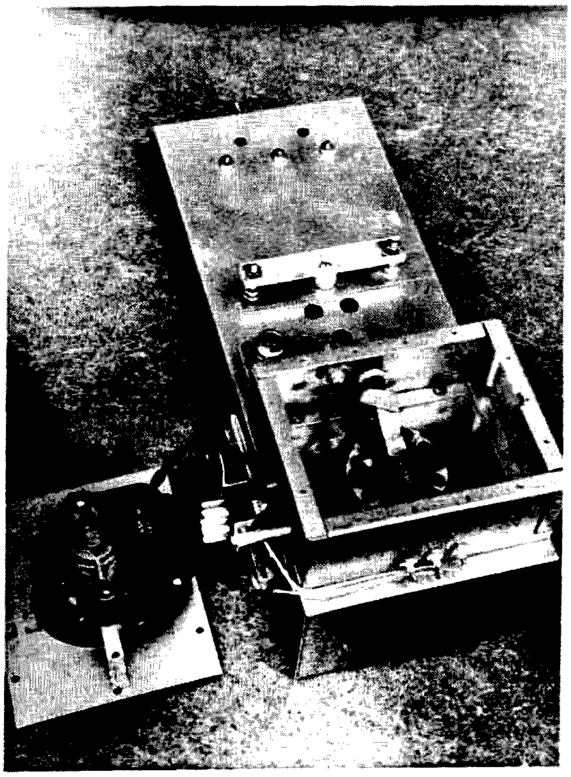
The tube used is a 4CN15A. Electrically, it is the same as the 4CX300A, but mechanically different in not having any air cooling fins. Fins are not required when vapor phase cooling is used.

Dissipation of plate power is accomplished by boiling water inside the plate trough. This holds the plate temperature at about boiling



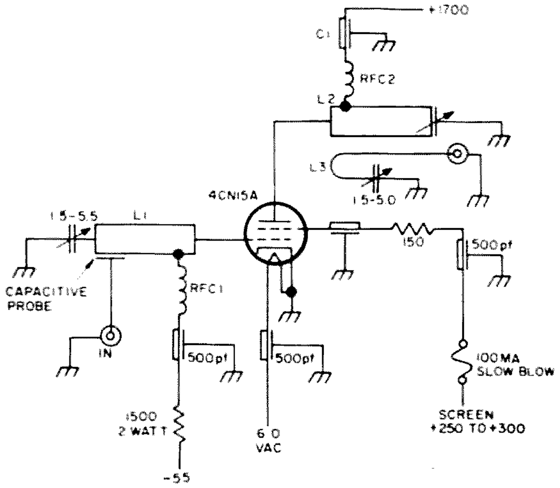
432 mhz amplifier.

The fan over the grid compartment cools the tube pins and keeps steam away from the socket. Braces are used to support the plate trough to allow more room for the standoff insulators.



Looking into the grid department.

Inside the grid compartment the tab capacitor can be seen attached to the BNC input connector. Filament, grid and screen voltages come through the capacitors in the end of the compartment.



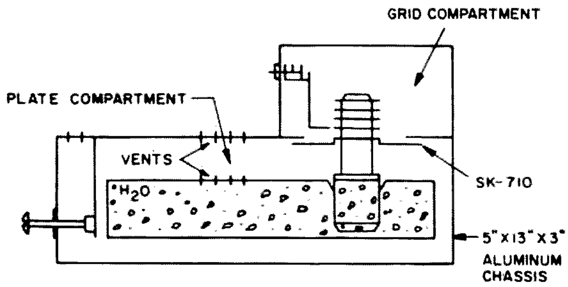
Schematic of the 432 amplifier.

temperature (100° C). As more power is dissipated the water boils harder but never gets any hotter. The tube anode is actually somewhat hotter than the water because it is not entirely immersed. Being inside the plate trough, the water is separated from *rf* and dc fields, and therefore causes no electrical problems.

W6MJG built a vapor phase cooled hf amplifier (May 1966 QST) that used many special pieces of hardware. He had a closed cycle operation using reservoirs and condensers to save the water. But why? Water is cheap! Here we let it boil away into the air. The rate of usage for intermittent amateur operation is modest; one filling normally lasts several evenings.

Construction

The construction of the amplifier is clear from the drawings and pictures. Half wave, capacitively loaded lines are used in the grid and plate circuits. The grid line is made from flashing copper and tuned by a 5 pf variable capacitor. Coupling into the grid circuit is by a capacitive probe also built from flashing copper. This is adjusted by bending to maximize the drive. A small fan is mounted over the grid circuit to cool the tube pins and prevent steam from coming up through the tube socket. A slight modulation can be heard locally from the fan blades passing near the grid

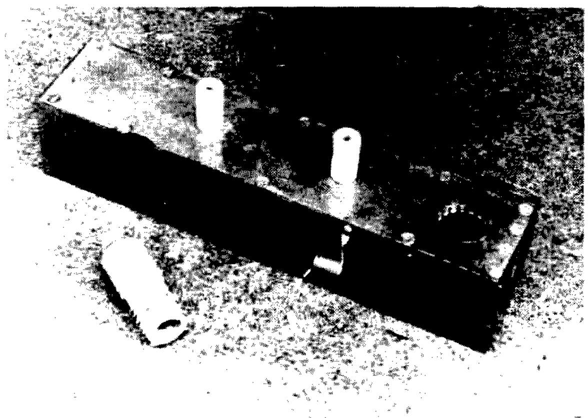


Water inside plate trough boils to keep the tube plate temperature from rising above 100 °C. Steam escapes from ventillation holes in the plate trough and plate compartment.

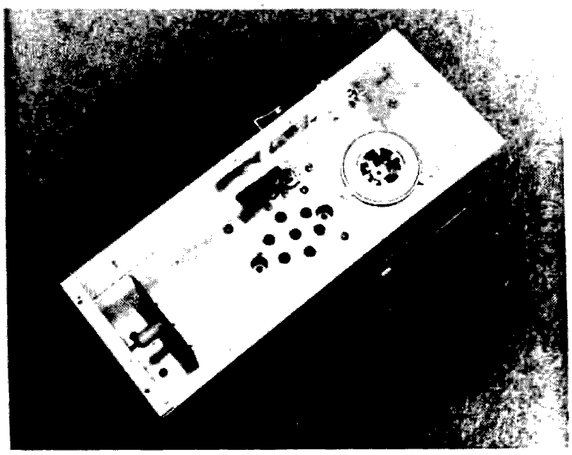
circuit. A wire mesh shield could be used to prevent this effect.

Brass stock 2"x1/16" is used to make all sides of the plate line. Since, mechanically, the line is a water trough it is made leak-proof by careful soldering of all joints. Acid flux is used and, after soldering, thoroughly scrubbed out. The top of the trough is made removable for cleaning.

Electrical contact to the 4CN15A is made



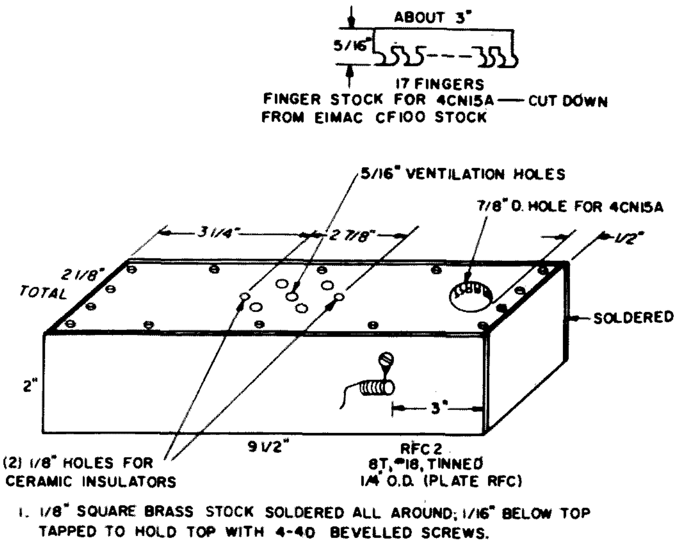
The plate trough corners are all soldered except those holding the top cover. Fourteen flat head screws hold the top and allow access for cleaning.



Basic simplicity is seen in this underneath view with the plate trough removed.

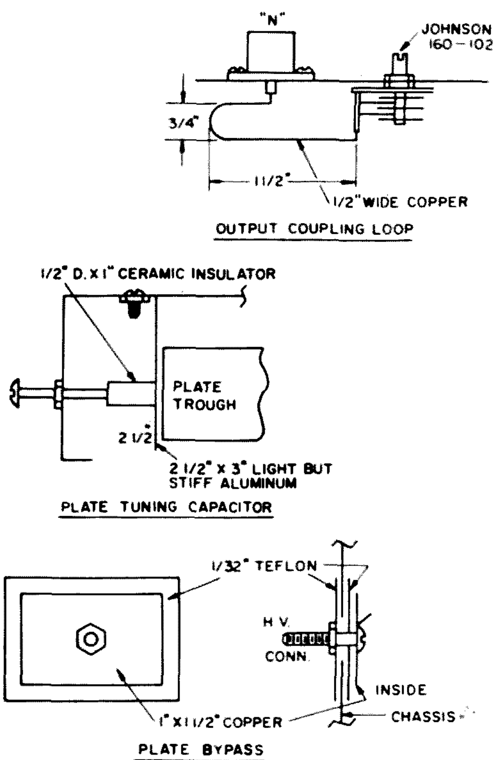
from cut down Eimac CF100 finger stock.

The outside of the plate compartment is a 5x13x3 inch chassis. Ceramic standoff insulators are used to support the plate trough. In order for the tube anode to protrude as



Dimensions of the plate line box.

far as possible inside the plate trough, the clearance left is insufficient for standoffs inside the plate compartment. For this reason braces are mounted over the main chassis as can be seen in the photos. The height of the

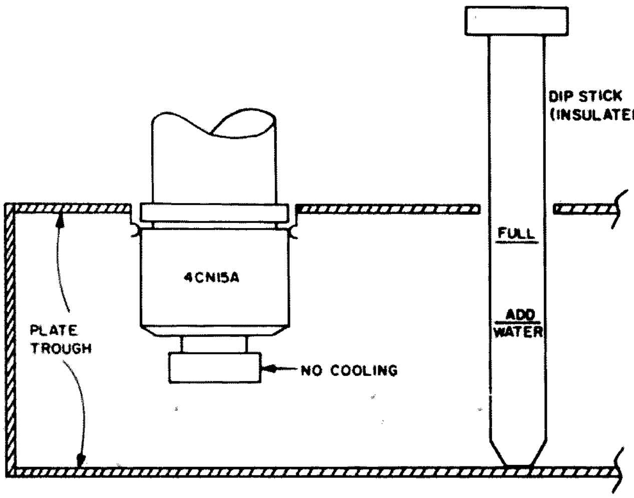


Details of construction.

plate trough is adjusted so the anode seal is flush with the top of the trough. The plate tuning capacitor is a sheet of "springy" aluminum, operated by a 10-32 screw with a ceramic insulator between the screw and the aluminum. When the amplifier was first assembled, the insulator was not used and considerable arcing took place at the metal-to-metal contact.

Operation

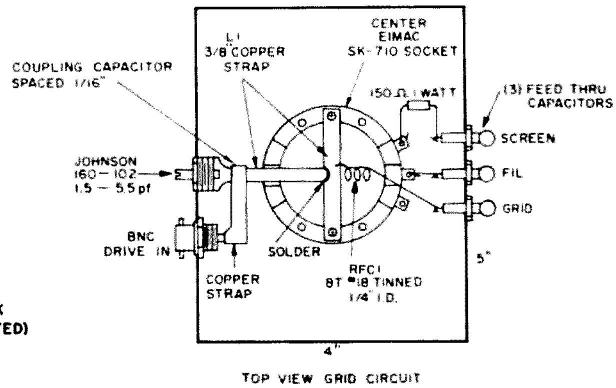
The maximum power capacity of the amplifier is difficult to determine. The maximum allowable temperature for the ceramic-to-metal seal is 250° C. Measurements of the seal temperature were made using Tempilac indicator with no *rf* applied. It was found that the tube can dissipate well over a kilowatt in a good rolling boil (see graph). About 200 watts is dissipated with no boiling occurring. Thus, in general, dissipation of heat is not a limiting factor for amateur power levels.



View of water levels inside plate trough. Water must cover part of main body of the tube. Small portion on end of tube is a seal cover and cannot conduct any quantity of heat.

Manufacturers specifications for CW operation limit the plate voltage to 2000 volts and the current to 250 ma. This gives an input of only 500 watts. However, this amplifier has been operated for many hours at a kilowatt (2500 volts, 400 ma) with no sign of tube deterioration. At W2CLL, the amplifier has been operated at 500 watts for general operation and a kilowatt for schedules and band openings for the past three years using the same tube with no drop in output.

About 25 watts of grid drive are required for full output. This gives 25 ma of grid current at about 90 volts bias. The screen voltage is adjusted to give the desired input. This requires about 250 volts for 500 watts input and 300 volts for a kilowatt. Screen current is usually not more than 10 to 15 ma and, under some conditions, will be 5 or 10 ma negative. The plate current dips at resonance but the best tuning device is a power output indicator. Another method of tuning at high power levels is for minimum boiling sound (this requires a reasonably quiet room!) Efficiency generally runs about 50%.

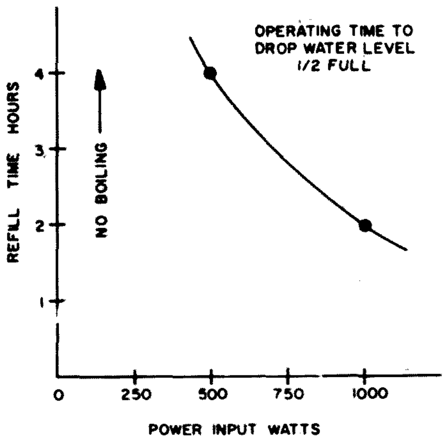


Grid compartment details.

Screen modulation has been used for AM operation. Here the screen is dropped to about 100 volts for a carrier power of about 100 watts. About 300 peak-to-peak volts of modulation is applied from a modulator with 4000 ohms output impedance. This was a push-pull 6146 modulator with 8000 ohms output impedance, swamped by an 8000 ohm resistor.

The trough is normally filled to within ¼" of the top and allowed to boil down to half the tube length before refilling. An *insulated* dip stick is used to measure the water level with *power off* and the high voltage grounded. Remember, full high voltage exists on the plate trough. Filling is done by siphoning water from a bottle with a length of ¼" plastic aquarium air hose. The hose is placed through a ventilation hole.

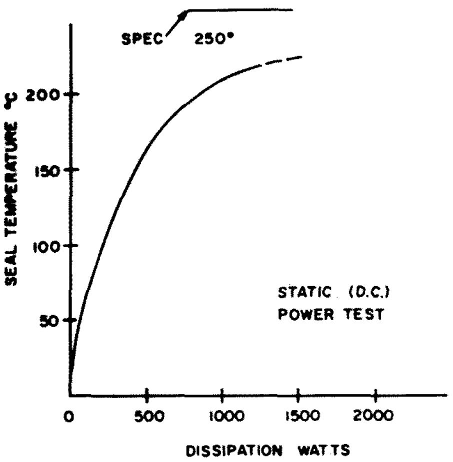
Distilled water is not required, since no voltages are impressed across the water. However, if tap water is used, deposits will build



up inside the trough necessitating frequent cleaning and making distilled water a worthwhile convenience.

Modifications

Although finless tubes such as the 4CN15A are mechanically ideal for amplifiers with "poor man's" vapor phase cooling, almost any external anode tube with ceramic insulation can be used. Check the temperature rating on the seals—if they are 250° C or higher there should be no problems. Glass-to-metal



seals are generally rated at 150° C which is not far enough above the 100° C boiling point to be safe.

A version of the 2C39 series, the 3CPN-10A5, has no cooling fins and can be easily used in this type of amplifier. Additionally, many of the 2C39A's have their fins held on by a set screw and can be easily removed.

Some additional ideas may be obtained from the 220 mhz amplifier described by K2UYH (July 1968 CQ). This amplifier used the 4CX250.

...W2CLL

4 Thirty Two'er

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Annapolis, Md. 21403

432: a band just itching for new operators. Sooner or later, most VHF'ers want to try this frequency. But here they run into a problem; little, if any commercial equipment is available for 432. The operator must either convert surplus or build the entire system himself. Of course, the gear can be as simple or complex as the builder's funds allow, although most will agree, it's better to start out with a simple station and work up.

Here are two simple, easily constructed adapters for the Heathkit Two'er which will allow the budding 432'er a glimpse at the band. Granted, no DX records are going to be set by these little units, but solid contacts 5 to 10 miles are possible with good antenna systems. An added feature is that they still remain useful around the shack as *rf* monitor, signal source, converter and so on, when more elaborate equipment is later added.

Transmitting Converter

From the dark recesses of a basement, an old, well-punched mini-box was recovered. Measuring 5x3x2½ inches, it was decided one-half was to be used for the transmitting converter, saving the other for the receiver section. The parts were arranged about the chassis as in *Fig. 2.* Their placement is quite critical, so in duplicating the unit, follow the layout closely. Especially pay attention to

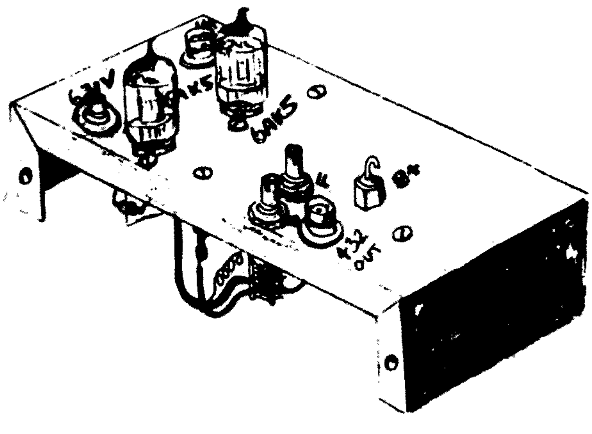

Fig. 1. Transmitting converter built in Mini-box.

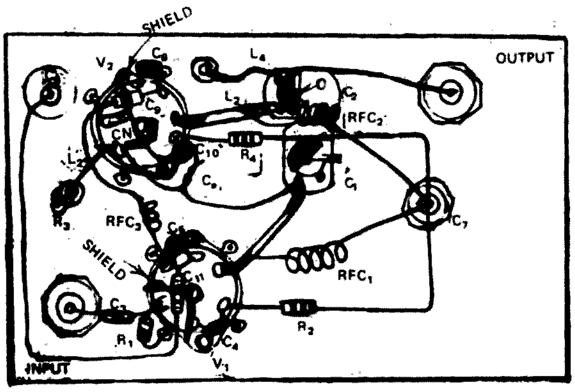

Fig. 2. Parts layout for converter.

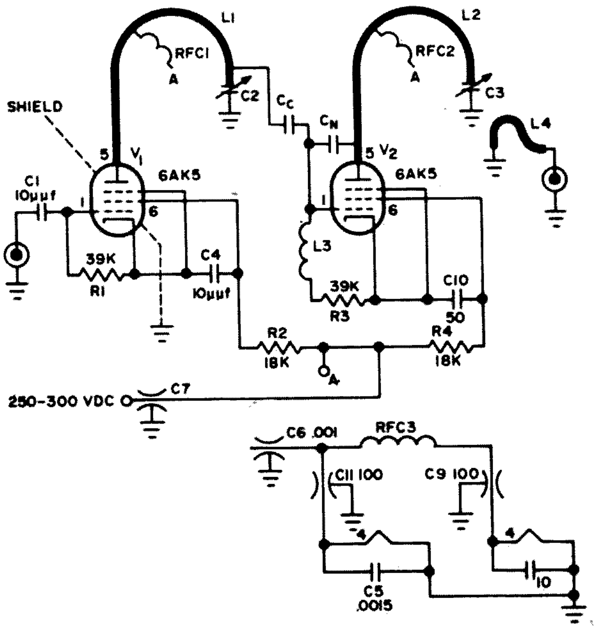

Fig. 3. Schematic of converter.

the way the keys on the tube sockets face.

For those who are just wetting their feet in UHF, (for whom the article is really intended) at these frequencies, please remember that lead lengths just *aren't.* Any stray inductance or capacitance at the UHF's will cause unstable operation. That is, if the rig will function at all!

Small isolation shields are soldered from the tube socket center pins to ground, in such a manner as to separate the plates from their grids. These shields are about one inch long by half an inch high. If your sockets have grounding rings, puddle lots of solder about its and the shield's junction. Good, short connections are paramount. Lacking grounding rings, make the chassis connections thru large lugs, fastened to the same screws that hold the sockets secure.

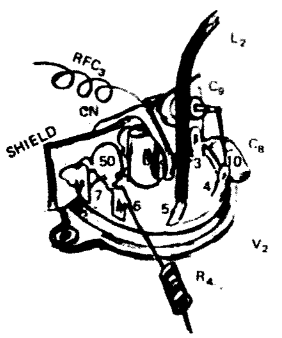

Fig. 4. Detail of V2 socket.

When scrounging tube sockets for these units, use only ceramic types. Bakelite and plastic ones just don't work at these frequencies.

The plate "coils" are hairpin loops of soft copper wire with small chokes connected at

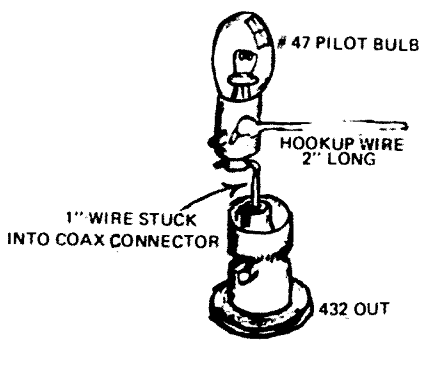

Fig. 5. Output load for tuning transmitting converter.

points (a) for Vl and (b) for V2, *Fig. 7.* The positioning of these chokes isn't too critical, nor are their values. The chokes are made by winding five turns of bare hookup wire closely spaced, a quarter inch in diameter.

Capacitor Cc is two lengths of insulated wire, each one inch long. The first runs from the junction of Cl and Ll, twisting two turns with the second wire, which comes from pin 1 of V2. This forms the coupling capacitor from the tripler stage to the final amplifier

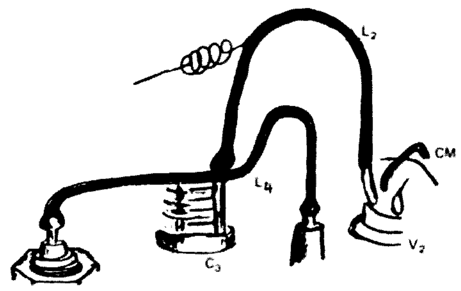

Fig. 6. Detail of L2 and L4.

Cn is also insulated hookup wire. Running ¾ inches from pin 1 of V2, over the isolation shield and close to pin 5, it becomes the neutralizing capacitor for the final. Its adjustment will be described later.

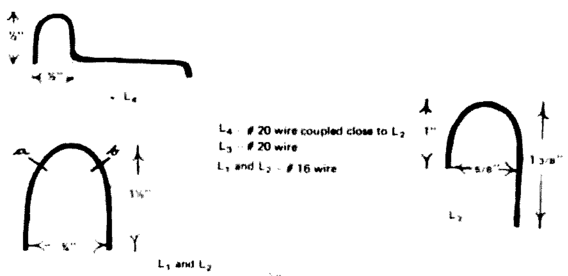

Fig. 7. Details of coils.

L4, which couples the final to the antenna, is positioned within 1/8 of an inch from the cold end of L2, *Fig. 6.*

Tuning Adjustments

A source of 250vdc and 6.3 v needed for the unit, may be taken directly from the Two'er. By tapping the high voltage off the transmit side of the Two'ers TR switch, the transmit/receive function may be controlled from this switch. After checking solder joints for poor connections and shortening that last bit of extra lead, already very short, you're set to try the rig out.

While it is warming up, preset Cl to 25% mesh and C2 to 75% mesh. Insert a dummy load made from a #47 pilot bulb into the output connector *(Fig. 5).* Keying the Two'er should cause the dummy load to light brightly. Peak Cl and C2 for maximum brilliance. Moving L4 nearer or farther from L3 may further increase power output. Check for neutralization by momentarily removing the crystal from the Two'er. The output should drop completely. If the dummy load continues to glow, move Cn to another posi-

tion near the plate lead until no output is obtained when the two meter drive is removed. At full power, there should be .2 MA of grid current between R3 and ground.

The transmitting unit is now complete and will deliver better than a watt of output power. I haven't attempted to modulate either stage of this converter, relying solely on the modulated two meter signal for audio. The result is a weird form of AM (mostly downward modulating) but seems to be copiable on any receiver. For the purist, modulation can be taken from the Two'er but you have to modify the unit to get it. Something I don't want to do; not now anyway.

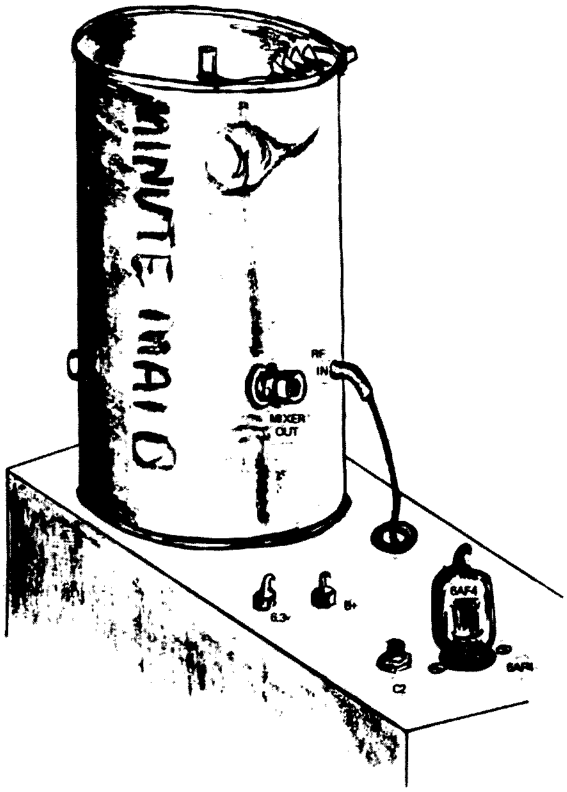

Fig. 8. Receiving converter layout.

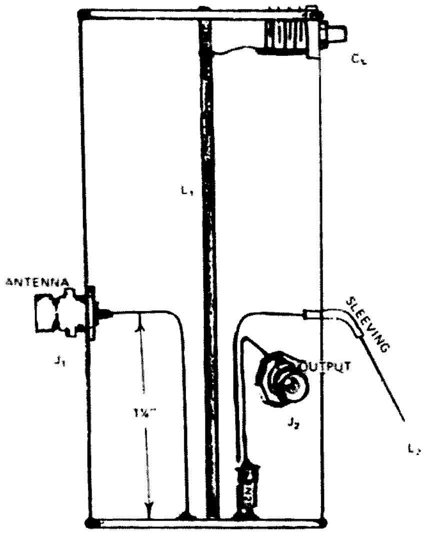

Fig. 9. Detail of mixer cavity of receiving converter.

Receiving Converter

The receiver end is probably the simplest project you're likely to build. A single mixer diode when coupled with the sensitive Two'er makes a good UHF receiver. And, after all, that is all there is involved in the modern UHF television tuners, which seem to do a fair job. If later you wish to add a transistor preamp, the combination makes a very hot little rig.

The second half of the mini-box is used for this converter's chassis. A fruit juice can (Minute Maid, 6 oz. variety) is mounted in a convenient corner. This will be the mixer cavity. Three holes are punched 1¼ inches from the bottom of the can *(Fig. 7)* and into two of these are mounted coax connectors for the antenna input and mixer output.

A miniature variable capacitor is mounted on the upper lip of the can and soldered to L1. L1 runs thru the center of the cavity. This capacitor will tune the mixer to resonance. The tip of a UHF diode (IN21, IN25) is soldered (watch the heat!) to the bottom of the can, close to L1. An easy way to attach this diode is first punch a hole thru the metal, stick the tip thru the hole, then solder it from the outside. Another wire runs from the remaining side of the diode to the output connector (again watch the heat while soldering).

If you feel lazy, a grid dip meter will do for the oscillator section of this converter.

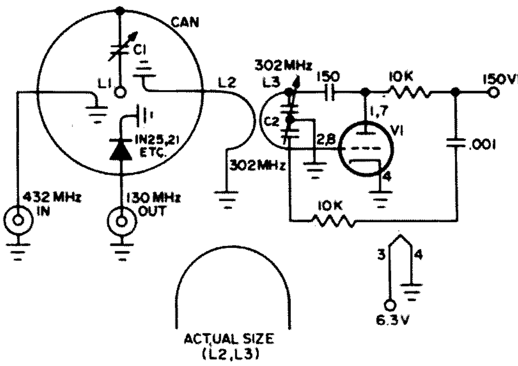

Fig. 10. Schematic of receiving converter.

Parts List

V1 - 6AF4.
L1 - #12 wire running thru center of can.
L2 - ½" loop closely coupled to L3, hookup wire.
L3 - ½" loop, copper strap.
C1 - 1-14 uuf.
C2 - 1-10 uuf per section.

However, for those who want a more permanent set up, I've included an oscillator in the schematic. By adjusting C2, the receiver will cover a very wide range of frequencies. Aircraft, CB, television and radar all make the listening more interesting if you can't find anyone on 432.

Tuning

But we're primarily concerned with 432 MHz, so to start off, first move the Twoer's receive frequency down to about 130 MHz. This is because the regeneration from the Two'er at 144 sort of messes things up at 432 (144x3–hmmm).

A piece of wire three or four inches long stuck into J1 will serve as an antenna during tune up. Like the transmitter converter, power for this unit can be drawn from the Two'er. Set the converter's oscillator near 300 MHz. Now radiate some signal at 432; it can be from another two meter rig's harmonic, a grid dip meter (if not already using it for your local oscillator), a signal generator, etc. A signal should then be heard at the Two'er. Now peak C1 for maximum signal and that's it. Finished, simple, huh?!

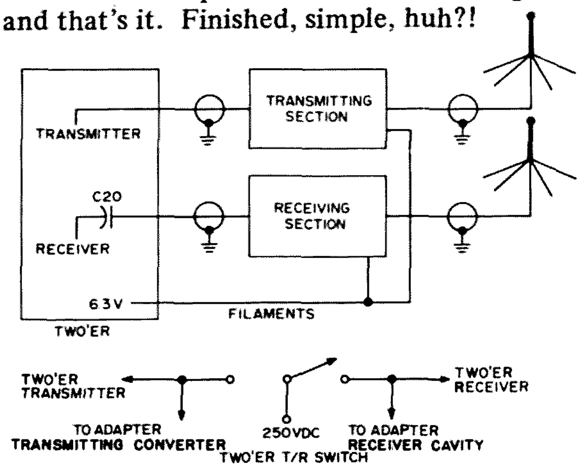

Fig. 11. Interconnections of converters to Twoer.

The system is now complete. All that remains is to connect the units up and begin operating. In order to put them on 432, you'll first have to disconnect the capacitor C20 in the receiver section of the Two'er, from the T/R switch. Reconnect it directly to the cavity mixer. This is the only real modification of the Two'er. Maybe you might want to by-pass this altogether by using a small relay to switch the Two'er from the transmitting converter to the receiving cavity.

Separate antennas are utilized for transmitting and receiving. Here again, a suitable *rf* relay can be used if you want to simplify things.

That's all the installation. You're now on 4 Thirty Two. ...WA3AQS

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CW Can Get Your Goat

Dear avid and sometimes rabid readers of 73. I am sure you recall my initial contact with Rotaciraverp which was so graphically described in a recent issue and how the goat ate the converter which made this contact possible. Also the dit dahs which began to emanate from the goat, possible due in part to having swallowed an 807. And, that I thought my friend Rota (for short) was trying to contact me through the goat, using dit dahs. Well, early one evening when the moon was low, I later refilled the jug, don't drink myself but the goat sure got hooked after one 807, it seemed that the dit dahs were beginning to form strange sounding words. Suddenly I realized why he sounded like off-resonance SSB when he was talking to me. These people pronounce their words backwards so, naturally, talk backwards. I have the ability to reverse my mental facilities and did it without thinking. We have a name for people who do this but I don't remember what it is. Other people talk in circles and they are called politicians.

I began to copy the letters which spelled Moolb Alyak and suddenly I realized the score. Personally, I use that new product called Tint Scalp. Now I want to clarify something once and for all and that is that the following has no reference, insinuated or otherwise, to our dear sweet editor who has shown such a compassion for the trials and tribulations of the Little People. It is pure coincidence and nothing more that when this small bundle of femininity burst upon this earthly scene for the first time, kicking and squirming and squalling loudly, her parents named her Kayla and I doubt that they could have known she was to become a Ham. Nor do I make any inference to her having what is commonly called a big mouth. But it is odd that the reversal of the letters of her first name spells Alyak, pronounced All Yak which seems to be a by product of this means of communication whereby everyone becomes a faceless personality who looks like a loud speaker. On the other hand, it does seem strange that she should become editor of 73 and that she would be the one to reveal Rotaciraverp to the electronic denizens of this planet called earth and that her name would be so closely linked with the stock in trade of this hobby. Could it be possible that Rota foresaw all this? The use of thought transmission gives him unlimited possibilities and I am glad that he is the benevolent type and he assured me that he had nothing to do with the birth of the "Great Society."

Rota flatly refused to give me the name of their planet or its spaceographic location. He said they had no desire to have someone with more of the taxpayers' billions than common sense making their outerspace a rocket wrecking yard. He doesn't blame people for wanting to escape the mess they have made on this planet but as he said, "Why mess up another one?" He did tell me which way to point the goat's horns for the best reception but made me swear an oath stronger than a politician's promises before election that I wouldn't reveal it.

The atmosphere on their planet is made up of a blend of electrons from conductors and non-conductors with a dash from semiconductors thrown in. Thus, when they breathe, they get a mild tingle rather than a severe shock and in comparison to our polluted atmosphere is pleasant indeed. At one time they all got on an electronic drunk

due to a malfunction of the blending machine which fortunately righted itself: but if you have never had an electronic hangover, you don't know what a hangover is. The liquid they drink is beyond description in that it is akin to voltage as we know it. After the planetary binge, some of the residents with a tendency toward alcoholism started deep breathing exercises and drinking heavily of their liquid in an effort to recapture the feeling of intoxication but it didn't work so they said, "Watts the use," and gave the idea up. Speaking of watts, they have no need to eat anything because by breathing and drinking they have all the PEP they need.

Before marriage, the males and females are, atomically, in an ionic condition. The males have an excess of electrons, the females are short a few and I didn't say marbles. When an ioness sees an ion with a magnetic personality who attracts her, she exerts a great deal of perveance and tries to bypass his capacity to resistor. However, as usually is the case, his dielectric breaks down which, in turn, short circuits the impedance he has generated and he cannot choke his reactance towards being resonant through mutual inductance. The marriage ceremony is simple in that they step into a converter, a heterodyning process takes place and they become atomically balanced. Being in a balanced condition, their toroid hysterisis for each other collapses and they phase life with a minimum of harmonic distortion.

The men enjoy fission and sometimes catch a gamma ray if they beta hook properly. Fish or no fish, they love to watch the oscillations on the newclear pool. Or they will go down to the village square and try to talk the squares into cutting off their beards and long hair and taking a bath. If they desire children, they have a computerized propagation machine which delivers children according to the frequency allocation. Once and only once, the computer delivered an atomically balanced baby and later they named it "Millie Henry." If the men get mad at their wives they call them meghertz and if you have been married as long as I have, you know how painful that can be at times. On other occasions they tell them to shut their ion traps and neutralize the feedback but, being females, this doesn't seem to phase them because they are determined to have the final output probably due to their natural excitation.

The barbers are called trimmers and some people think their clippers should be applied to their modulators. Although they seem crude, they have counterpoise and broadcast audio which contains some bias and needs filtering. Some people wear pigtails and this shunts business away from their station. A barber named Pico Farad got over charged about this and degenerated to the point where he couldn't sine his log.

Molly Cule married Mike Rofone who was quite an emitter. Mike was a collector of germaniums which bothered Molly's sineus because of the field effect and she had to give him the gate. He tried to tell her that it was caused by negative bias but she was positive and told him to take his silly con somewhere else because he no longer got to first base with her. Mike did a flip flop and started practicing Yagi and was right in his element until he choked on a balun while trying to make a match with Sue Perhet. They tried artificial reactivation but got no reactance so poor Mike went to ground.

Just as things were getting interesting, trouble developed: the moon got low and the goat was high and started to hiccup. Now I have copied CW signals which sounded like a chipmunk burping under water and others which sounded like someone keying the power line. Or the catch-me-if-you-can boys who drift up and down like a yo yo. And then we have the high speed boys who send part of a word about 17 mistake symbols of their own choosing and finally get the other two letters for a grand finale. All this is bad enough but you try copying a goat with the hiccups. Here a dit, there a hic. There a dah, here a hic. I gave up on the copy and as I was leaving, the goat was weaving and heaving and the moral of this story is, "If you are a goat on the receiving end of Ham radio, don't get moon struck with CW (Corn Whiskey) and make a pig of yourself."

. . . K7TTA

Ed. Note: My secret is out! K7TTA has revealed to the readers that I am "out of this World." Actually, I was born at the age of 7, and for anyone to call me a "small bundle of femininity" is ridiculous, as anyone who has met me will attest. I am a large bundle of femininity. My Father, who's name is Llib, is 6' 4" tall, and my Mother, Neelhtak, is 4' 11". The probability of these two people ever having children is remote, so it was fortunate that I arrived by mail. I followed a brother by 3 years. They were pleased with him, so put in another order. They have never quite recovered from the shock, and now live in retirement in a small town in Ohio, where they are trying to forget the whole unpleasant incident. . .Kayla

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Rio de Oro the Easy Way

In the past ten years, peaceful Rio de Oro has become the rarest African country on the dxcc countries list. This is ironic since most of the rest of the continent has been politically disturbed during this same period. From 1956 until late 1966, there was a complete absence of amateur activity from Rio de Oro.

In September of 1966 the long silence was broken by Justo Perez, EA9EJ. It is strange that not a single dx publication carried news of this dxciting event. About eight weeks later, Justo was discovered by Eva, PY2PE, and the dx grapevines began to hum. Unfortunately, Justo spoke no English, could not copy SSB signals, and worked only on 15 meter AM. DX'ers are a plucky lot, though, and 15-meter beams began to sprout all across the country. With Eva's encouragement, Justo agreed to attempt to work some of the W/K gang. In mid-December, W3DJZ and a few others broke the ice with AM qso's, but the odds of making a qso for an East Coast station were formidable and for a West Coast station impossible. The biggest single problem confronting the North American dx'ers was that Justo's signal was always extremely weak.

Most of the Richmond dx gang needed Rio de Oro, and our six meter net was buzzing with ideas on how to improve our chances of making a qso. Frank, WA4HTR, offered to donate a used TA33 Jr. beam if we could raise enough money to air freight it to Justo. In the meantime, PY2PE and EA8CI made all the necessary arrangements with Justo. Since a twelve-foot package will not go aboard a DC-3, it was necessary for Manuel, EA8CI, to pick up the beam in Las Palmas and sea freight it the last 300 miles. When the beam arrived in March, I had no idea that this event would have such a bearing on my already planned European vacation. Shortly after the beam reached its destination, I learned that Jack, HB9TL, was sending one of his famous 20-meter transceivers to Justo. Jack's little rigs are similar to a Swan 120 except that they cover 14,000 to 14,320 and

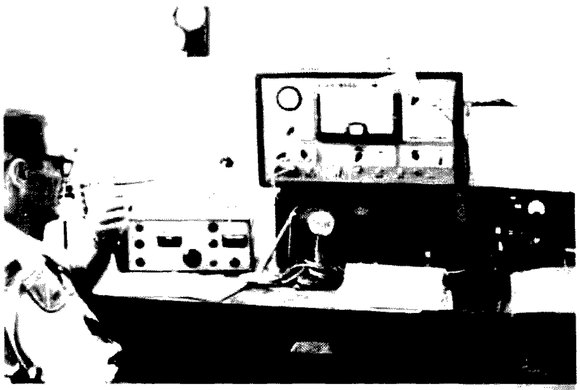


Fig. 1. Justo in his shack. Gear L. to R. is: HB9TL transceiver, Geloso transmitter, S-40 receiver and voltage regulator.

the transmitter portion can be crystal controlled for split frequency operation.

In early April the first two way SSB qso's with Rio de Oro took place. Unfortunately, the large number of expected qso's did not materialize. With Justo making an average of two or three contacts per day with the USA it was obvious that in the remaining year of operation only a small percentage of the stations needing EA9EJ would make a qso. Later I learned why most amateurs in Justo's circumstances would probably have made far fewer contacts, especially with English speaking stations.

As a result of qso's between Justo, Eva, and myself, we worked out a plan to break my European vacation for several days and fly down to visit Justo. The success or failure of the plan depended on whether I could obtain a visa to visit Villa Cisneros. Gus Browning, the Colvins, and others told me that it was impossible, but I had one thing going for me which they didn't–inside help. With six weeks left before our departure date for Europe, I applied for a visa. I was told that my application would either be granted or denied within three weeks. Five weeks later, when there was no word from Madrid, the whole idea was scrapped. Just five days before our scheduled departure for London, a WA3 called me on the telephone and told me to come on 15 meters immediately as Eva

had urgent traffic for me. Eva had just spoken with Justo and he had informed her that an authorization for me to visit Rio de Oro was waiting for me in Las Palmas! Justo had interceded on my behalf with the governor of the Sahara, and the governor had telegraphed the permission to Las Palmas. I immediately wrote to Justo and asked him to send a confirming letter to Amsterdam before July 29 if everything was still go. This seemed safer than flying from France to the Canary Islands merely on the strength of one relayed radio message.

On July 19, my xyl, Rosie, and I flew from New York to London. Space does not permit me to relate what a wonderful group the G gang and their ladies are, but I must mention just one example. George, G3LNS, and his fiancee, Sylvia, took us for an all-day excursion through the English countryside, where we visited such interesting places as Salisbury cathedral, Stonehenge, Stratford-on-Avon, and many others. When we arrived in Amsterdam on July 25th, the confirming letter from Justo was waiting for me. Justo told me to give up the idea of bringing a generator along. I interpreted this to mean that the long-promised 24-hour electric power service for Villa Cisneros was now in effect. Eleven days later I would have given my OK7HZ/ZA qsl for the little generator George offered me while we were in Birmingham, but that's getting ahead of my story.

To carry out the dx'pedition successfully and still not foul up the rest of our trip, I needed bookings on five different flights. A single miss would leave things in a terrible mess. My travel agent in Amsterdam put all five flights "on request" but was unable to confirm a single one before we had to leave for Paris. Our plans called for me to leave Rosie on August 4th and fly from Bordeaux to Las Palmas. On Saturday, the 5th, I would pick up my visa and catch one of the tri-weekly flights to Villa Cisneros. Flying by way of Las Palmas and Madrid, I was to meet Rosie in Barcelona on the 9th. Meanwhile, Rosie and two friends would drive from Bordeaux via Andorra to Barcelona. When we reached Paris on July 31st, I was able to confirm the Bordeaux-Las Palmas flight with Air France. As for the four remaining flights with Iberia I would just have to hope for the best.

Early Saturday morning I went by the Sahara Administration Office in Las Palmas to pick up the promised visa. With a little luck, I should have the visa and airline tickets within an hour which would leave me the rest

of the day to see the island. The visa was issued within twenty minutes, but then my luck began to run out. I was told to go to the post office and buy a 3 pesata stamp for the visa. Then I was to take the visa to the Las Palmas police for their validation. I wasted 30 minutes looking for the post office and finally wound up buying a stamp at a news stand. Since the Las Palmas police station was on the opposite side of town, I caught a taxi to save time. Ten minutes and six *pesatas* later the visa was duly validated by the police. Rio de Oro seemed a lot nearer now.

With just such pleasant thoughts in mind, I took the first long hard look at this magic carpet which had eluded so many dx'peditioners before me. To my horror, my eyes fell on the phrase, *"Y con una duracion de 48 horas."* The return flight from Villa Cisneros to Las Palmas was not until Tuesday evening, 72 hours later. I walked back into the police station and attempted to explain this to them. The officer just shrugged his shoulders and said it wasn't of any concern to him. The Sahara Administration officials didn't seem inclined to issue a new visa although they did find a second telegram in their files authorizing a 72-hour stay.

I taxied back across town for the third time to the Iberian Airlines office. Unfortunately, the Iberian representative refused to sell me tickets on the basis that I could not possibly return before the visa expired. I explained to her that I had already made a second trip to both offices about this and everyone said that the present visa was satisfactory. "Oh, yes, but when you get out to the airport (20 miles from town) this evening the airport police won't let you board the plane." At this point, I practically got down on my knees and begged the little girl to phone the airport police, explain the situation to them, and find out if they would let me board the plane. An hour later, she came back smiling. Yes, I could go, but she couldn't promise what would happen to me when I was ready to return. Since I was going as a guest of Teniente Coronel Perez, second highest ranking officer in the Sahara, I decided to take that risk. By this time, it was too late for a tour of the island, but at least I could relax for a change.

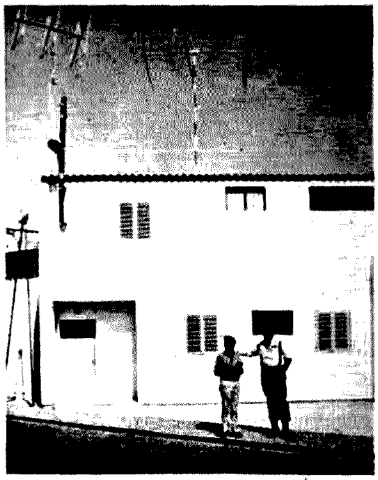


Fig. 2. Justo and son in front of his house. Quad is for TV reception from Las Palmas. TVI was a problem! Note how the wind blows the TA33 Jr. elements.

The little T-47 took off promptly at 7:00 p.m., and 90 minutes later I could see dim lights of a small village. The runway was outlined with a row of smudge pots, but this seemed to be adequate for a safe landing. Just as I reached the fence a tall man stepped forward and said, "Bob!" It was Justo, accompanied by an English-speaking military chaplin, Father Eusebio Espinosa. Justo said a few words to the police, and I was informed that I could stay in Villa Cisneros as long as I liked.

At 21:39 GMT, I logged W2FXA for the first qso. I had expected to work 100 stations per hour easily, but when the first twenty minutes produced only four qso's, I began to realize that something was wrong with my signal. The transceiver seemed to be working satisfactorily so the trouble had to be in the antenna. To make matters worse, Justo informed me that the power was off daily from about 00:50 GMT until 07:00 GMT and that from 07:00 until 19:00 the regulation was so poor that operation was impossible. As the evening wore on, conditions gradually improved and by 00:45, when I went qrt for the night, my qso rate was up to one per minute. I made a dash for the officers' barricks, and, just as I finished undressing, the lights went out abruptly. From my second story window, I could see most of the village, and to my surprise there were a few electric

Fig. 3. The Villa Cisneros skyline.

Fig. 4. Justo's legionaires drilling on a Sunday morning.

lights still burning. If I could just figure out a way to get some of that power!

In the morning, Father Eusebio and Pvt. Allen Marcos, an English speaking legionnaire, whom Justo provided as a valet, took me sightseeing through the village. I was pleasantly surprised to learn that I could take pictures of anything I wished. Roughly, half of the population is Arab with a few of their darker-skinned former slaves and the other half mainly Spanish military personnel with their dependents. After lunch, Justo decided we should try 20 meters as the power regulation seemed better than usual.

The first thing I heard was friend George, G3LNS, calling CQ AFRICA right on our crystal frequency. It was a pleasure to repay some of George's kindness by giving him a new country the easy way. The next hour's operation produced only a dozen contacts, so I decided to see what could be done about the antenna. An ohm meter revealed that there was 10,000 ohms resistance across the feedline when it was disconnected from the transceiver. Since the TA33 Jr. has a split driven element, this had to mean trouble in the line or its connectors. I traced the line to a DPDT ac-type knife switch. From the switch it ran up to the wall where it was spliced to the main cable from the beam with two wood screws. With Justo's permission, I decided to run the line directly to the transceiver. As I disassembled the line, I discovered that the braid of the RG8U wasn't soldered to the PL-259. The center conductor was soldered, however, and Justo's soldering iron was still cold. A soldier was dispatched to find another iron. An hour later, he returned with a mighty fifty watt job. In the meantime, I had prepared the end of the coax to receive the salvaged PL-259. Unfortunately, the braid was so corroded that I couldn't clean it adequately to make a good solder joint, especially with a fifty watt iron. With the job completed, the line still read 10,000

ohms across the end so apparently the trouble was in the line itself. I asked Justo through my interpreter if I could replace the feedline with the new coax which we sent with the beam. No, it was impossible to reach the beam without taking it down and with the high winds he didn't think it should be taken down.

Since there was no possibility of improving the antenna, I began to explore the idea of some source of power from 01 to 07 GMT. Every lead drew a blank. There just simply wasn't any way that I could get the transceiver, an antenna, and a power source all together for those hours of optimum propagation to the States.

Since 1956, no W6 or W7 stations had qso'd Rio de Oro and at this point, it was beginning to look as though there might not be any qso's in the next eleven years either. Then at 00:39 GMT, with a scant eleven minutes of power left, Allen, K6YRA, broke through for the first west coast qso. With numerous repeats, I managed to get five Californians in the log before the shack was plunged into darkness. The next morning, as I was having coffee in the mess hall, Justo came bursting through the door and excitedly announced that he had worked two W6's. Obviously, my planned trip into the desert with the Spanish army would have to be given up. In the next hour, I logged 74 stations of which 61 were sixes. The 07-09 opening was a bonus I hadn't expected, and luckily the power regulation held out just long enough.

A second unexpected bonus materialized from what was supposed to have been a joke. Since Justo does not work CW, Eva had suggested I take him a gift of a hand key as a gag. With my SSB results not up to expectations, I decided to try CW. In order to work CW, I had to hold the mike in my left hand since the PTT button was the only transmit switch the little transceiver had. With a mike in one hand and a straight key in the other, I managed around 250 CW qso's in five hours operating time. With a little advance notice, the number would have been much higher.

On the last afternoon of my visit to Rio de Oro all of the native musicians and dancers were assembled to put on a show for me. The stars of the show turned out to be two eleven year old female dancers. It was difficult for me to believe that these two little girls were already married. As the show progressed, we all sat around with our legs crossed drinking syrupy Arab tea and eating spiced camel meat off of metal skewers.

Fig. 5. The eleven year old dancing girls at farewell party.

This was a grand climax to a wonderful three days in Villa Cisneros and it made me wonder why any dx'peditioners would want to spend their time on some barren uninhabited rocks in the middle of the ocean which have absolutely no cultural value. After the show, I went back to the shack for one final operating session. At 20:28 GMT on August 8th, I pulled the switch after a final qso with I2LAG. Twenty hours later, I was getting a big welcome back kiss from Rosie at Barcelona.

A check of the logs showed that in twenty-two hours operation a total of 801 qso's were made with all US call areas and all continents. Although 11 percent of the contacts were with the sixes only two sevens, K7GCM and K7ABV, were worked. VK4YP was the only Oceania station worked, although others were heard and called. Contrary to the claims of one of the better known dx'peditioners that most of the "big gun" W/K dx'ers are lids, I found the exact opposite to be the case. Both the big guns and small fry behaved extremely well. When I asked for particular call areas, everyone who copied my request cooperated, and I rarely had difficulty copying reports being given to me.

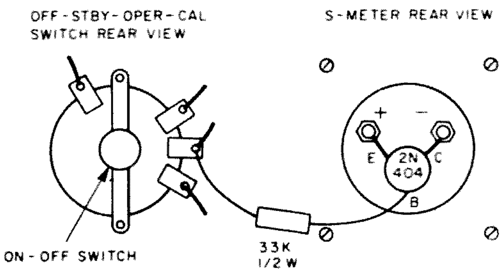
For those who still haven't worked Justo or myself, I suggest learning a little Spanish. If you will just learn your call letters and his call letters in Spanish, your chances of making a qso will improve 100 percent. If you could not speak Spanish, as Justo cannot speak English, can you imagine how difficult it would be to identify a single station out of twenty South Americans calling you in Spanish on the same frequency? My advice is—do your homework, monitor 14,115 and 14,125 and hope for the best.

...W4QCW

METER DE-PEGGING CIRCUIT

Does your S-meter peg when you switch from operate to standby? We had that problem with our Heath SB-301 (a really fine receiver, by the way) and it was annoying enough to be worth fixing.

All it takes is a 2N404 transistor and a 33 to 100K resistor. Install the transistor across the S-meter with the emitter to the + side and the collector to the − side of the transistor, saturating it and thus just about shorting it out.



Let the receiver warm up on STBY until the filaments are warm and the mute voltage is available for the meter protection.

This should be helpful for any piece of equipment that has this problem.

Michael Tenore, WB2LCW

Trouble Shoot Your Antenna from Indoors

Neil Johnson, W2OLU
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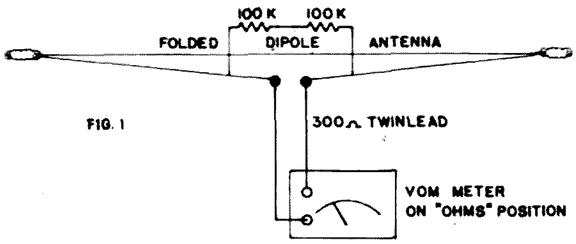
Tappan, New York 10983

Would you like to shoot trouble on your TV or short-wave antenna without going outdoors? It can be done, without the need for any complex instruments. The cost? Just a few cents. Here's how it's done. Assuming your antenna feeds into a transmission line of the 300-ohm type—this applies to most installations—the trouble shooting setup becomes simplicity itself: two carbon resistors, plus an ordinary ohmmeter (**Fig. 1**).

Two composition resistors, of values approximating 100K ohms each, are connected in series. This combination is then connected to the "top" end of the twin lead, where it joins to the antenna proper. Now...the twin lead is disconnected from the equipment which it feeds, such as TV receiver or short-wave apparatus. The normal reading for a "folded-dipole" type antenna installation will be in the order of a few ohms, possibly as high as 5 or 10 ohms at most. Should a break occur in the antenna or "flat-top" portion, the ohmmeter will read in the neighborhood of 200,000 ohms. On the other hand, if the meter readings should be extremely high, it is safe to assume that the twin lead coming down from the antenna has a break in it somewhere. Through this simple process of elimination, the experimenter quickly pinpoints the area of trouble. This reduces the total time needed for diagnosis and repair. It will also eliminate, or reduce, the need to climb over hazardous rooftops, thus cutting down on a few bruises, or possibly broken bones.

This scheme, using resistors, is not confined to antennas of the folded-dipole type. Many short-wave and TV antennas have a single conductor for the flat-top, such as a copper wire or an aluminum rod or tube. Breakage in the antenna proper is thus easily spotted. But twin-lead breakage, concealed inside a plastic overlay, cannot be detected without a minute and close-up inspection. Rather than needlessly risk a broken arm or leg, why not put two ten cent resistors to work? (**Fig. 2**).

FIG. 1



#1 Possibility: Ohmmeter reads "low ohms," 5-10 ohms maximum. System OK.
#2 Possibility: Ohmmeter reads 200K ohms, folded dipole section of system disconnected from feedline; or, folded dipole "open."
#3 Possibility: Ohmmeter reads much higher than 200K ohms, the feedline has an "open circuit" before it joins the antenna section.

In the case of "intermittents," one of the hardest of all radio troubles to spot, sometimes the fault may be determined by placing the ohmmeter terminals across the lower end of the down-lead, while at the same time keeping a sharp eye on the ohmmeter and simultaneously shaking the twin lead. The few check-points in this elementary "system" are not a 100% cure-all, but each only takes a few minutes' time; and in the majority of cases, diagnosis can be completed while the experimenter stands on "terra firma." Half watt resistors will suffice for all receiving set-ups, and 1 watt resistors will work out fine for all low-power amateur applications, both receiving and transmitting. Two watt resistors should be used for high-powered "ham" applications. In any case, very little power loss takes place through the resistors, since their total of 200,000 ohms is approximately 3,000 times the nominal impedance of a resonant dipole, or 70 ohms. The reason for using two resistors in series is mechanical, rather than electrical. Located as they are shown in the diagram, there is no physical strain on the resistors, and no chance for them to "open up." To avoid any chance of trouble, clean all connections thoroughly, and then solder them.

In addition to connecting the resistors to the antenna, trouble can be avoided by using twin-lead that is made with copperweld steel. The cost is no more, and it is far stronger than ordinary twin-lead, which is made with copper. Several manufacturers produce this "long life" variety of twin-lead. Belden offers these under several designations, such as type 8285 Permohm, type 8275 Celluline, and type 8230 Weldohm. Of these three, the last mentioned is least expensive. Amphenol makes

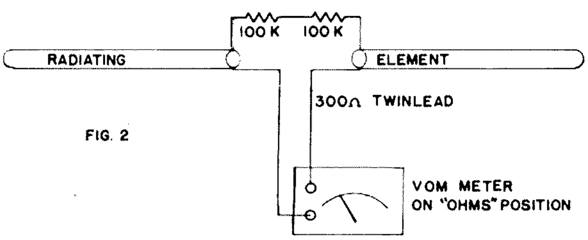


FIG. 2

#1 Possibility: Ohmmeter reads approximately 200K ohms. System is OK.
#2 Possibility: Ohmmeter reads very high, in megohms. Twin lead is "open."

a similar flat line, "Steelcore," number 214-559. A somewhat more expensive line by Amphenol is their number 214-022, which has two number 16 conductors and is suitable for transmitting amateurs. Other makers offer copperweld twin-lead under such names as "lifeline." If doubt should exist as to the wire's having a steel center or core, a small magnet will give an indication of the wire's being copperweld. If you have been having trouble with ordinary twin-lead breaking frequently, why not give one of these copperweld lines a trial? You will be impressed by their relatively greater durability. Through the utilization of long-life twin-lead, plus the resistor scheme, it should not be necessary to make that dangerous trip to the roof so often.

...W2OLU

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A Six-Meter IC Converter

This converter is one module of a solid state mobile receiver and transmitter designed, constructed and tested by the author. The advent of solid state devices make it possible to design highly stable receivers and transmitters which will operate directly from the car battery. The modular system was selected to insure adequate shielding between sections of the receiver and the transmitter and to facilitate changes in the system at a future date if desired.

The converter is constructed of two "ICs" and associated components. The one is an *rf* amplifier of 30 db gain and the second is a crystal oscillator, mixer, amplifier stage of 40 db gain. Evaluating insertion losses, the overall gain of the converter is 55 db. The factors considered when selecting the particular "IC" used were cost, availability and suitability. The Fairchild 703 operates as a differential amplifier of 20 to 30 db gain at frequencies up to 200 mhz and is inexpensive and readily available. The RCA CA-3028 is more expensive and can be used as an *rf* differential amplifier with nearly the same gain figure, but its advantage in this converter is that it can be used as a mixer, local (crystal or tuned circuit controlled) oscillator and amplifier of 40 db gain. The circuit employs a third overtone crystal in the series resonant feed back position of the oscillator circuit.

The shield placed across IC is necessary to prevent inductive feedback and self-oscillation of this "IC." The tuned circuit L1C1 is provided to match the antenna input to the converter and link coupled through a shield to reduce cross-talk and birdies being fed through the converter to the tunable *if* module (or receiver).

Construction

Construction was made on a vector board using vector board clips as mounting terminals. This form of construction permits substitution of electrically similar components without detriment to the circuit configuration. The vector board was cut to fit the standard 5"x2¼"x2¼" minibox and mounted with 5/8" nylon (plastic) standoff insulators. The metallic shields were made of sheet copper and soldered to supporting vector board clips. All resistors used are ¼ watt dissipation and the capacitors are either disc ceramic or mylar printed circuit type. The jacks for coupling the converter to the antenna and to the tunable *if* module (or receiver) are standard BNC jacks. Coil forms are ¼" nylon rod. Component layout is shown in Fig. 1.

Alignment Procedure

After completing construction use a grid dip meter or tunnel dipper to adjust the frequency of the LC combinations to the appropriate frequencies per chart.

Tuned Circuit	Frequency
L1C1	50 mhz
L4C2	50 mhz
L5C3	50 mhz
L6C4	Xtal Frequency
L7C5	IF out.

The *if* output will be the difference between the crystal frequency and the 50 mhz.

Connect the converter to a receiver set and apply power to the converter. Using the grid dip oscillator in the wavemeter condition adjust C4 for maximum *rf* signal when the dipper is near L6.

Next apply a 50 mhz modulated signal

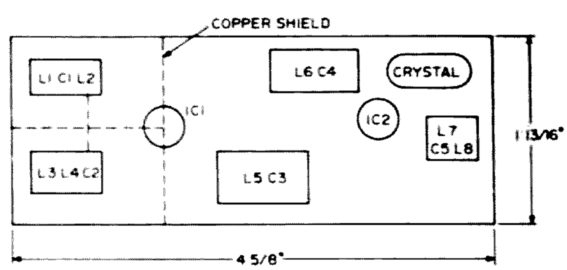

Fig. 1. Component layout.

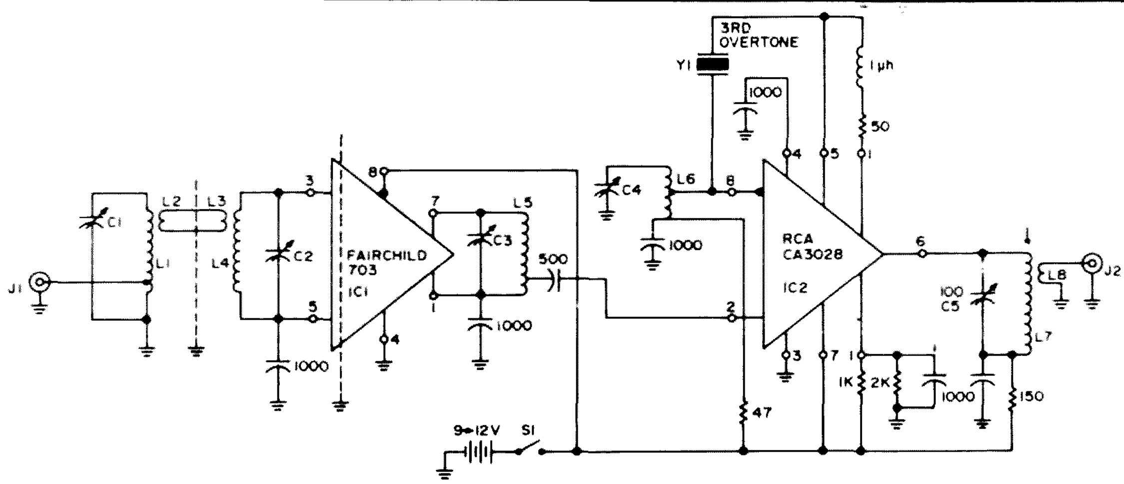

Fig. 2.

L_1 6T ¼" dia. closewound
L_2 2T ¼" dia. "
L_3 2T ¼" dia. "
L_4 6T ¼" dia. "
L_5 6T ¼" dia. " Tap 2T
L_6 6T ¼" dia. " Tap 2T

L_7 30T ¼" dia. "
L_8 3T ¼" dia. "

C_1 50 pf
C_2 50 pf
C_3 50 pf
C_4 50 pf
C_5 100 pf

Y_1 = Xtal 43.5 mhz for 6.5 ic.5 mhz *if*

R = ¼ watts
C = 50 vdc
C1-4 = 7-45 pf trimmers

from a signal generator to pin 2 of IC2 and adjust the receiver for the signal at the *if* output. Adjust C5 for maximum output. Disconnect the signal generator and apply signal to J1 and adjust first C3, then C2, and then C1 for maximum signal output. Repeat adjustments C5, C3, C2, C1 with the generator at antenna input (J1) because of slight interaction between adjustments. Remove the signal generator and connect the antenna. Happy listening to six meters.

...K2ZEL

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Radio Control Revisited

With no apology to Aldous Huxley,[1] the title of this article describes my intention and purpose quite adequately.. This article will up-date an article published in the September, 1963, issue of *QST* and, as in the case of "Brave New World Revisited," we must report changes that have materialized seemingly before their time.

The previous article covered the basics of radio control (rc) and defined a number of terms which have been specially applied in the literature on rc. It is suggested that the reader review the previous article if he is not familiar with the subject. Although many amateurs have contributed in large measure to the development of the rc hobby, the main body of enthusiasts has sprung from the ranks of the model aircraft builders. With this background it is easy to understand why the terminology tends toward the aeronautical vernacular. "Glitches" in the electronics are recognized as the cause of crashes but the "Red Baron" is a more likely cause of any spectacular "clobber."

High Lights of Recent Developments

The changes that have occurred are most noticeable in the electronics and the basic controlling elements, i.e., the control systems and the devices that drive the control surfaces. Radio control airplanes have not changed greatly except to become more functional. Typically, strip ailerons attached to the trailing edges of the wings which have almost entirely replaced the scale-like ailerons previously used. A number of new building techniques such as "foam wings" are prevalent. The particular technique involves the

W1QON, Eleanor Wilson, poses with W1-OLP's latest RC model called the "Seapprentice." This model is capable of water take-offs and landings. Seaplanes are a rapidly growing part of the R.C. hobby.

use of polystyrene (or similar) foam as a core and covering this core with sheet balsa wood. The result is an extremely crash resistant, warp-proof, light-weight wing.

Two phases of activity have had recent surges of interest. The first is that of radio controlled seaplanes and the second is radio controlled sailboats. The interest in seaplanes stems at least in part from the increasing difficulty in finding adequate flying sites for land planes. Lakes provide a large, flat landing area which is considerably softer than the usual landing area. Water take-offs and landings can be easily made into the wind since no "landing strip" limitations exist. Airplanes can be water-proofed without much difficulty and, in general, the life of a seaplane appears to be longer than its land equivalent.

Sailboat interest has been prompted by the availability of kits and hardware for relatively large racing type models. The hardware in-

1. In the 1920's Aldous Huxley wrote a science fiction novel entitled *Brave New World*. It dealt with a situation in the year 2,000, some 80 years in the future. In 1963, less than 40 years later, Huxley wrote a sequel, *Brave New World Revisited*, which pointed out how many of the things he described as existing in 2,000 actually existed in 1960.

cludes special servos which operate winches for trimming the sails as well as for setting the rudder. These models stand six to seven feet tall from topmast to keel and tend to be expensive if one goes the route of buying a fiberglass hull and a ready-made suit of dacron sails.

Transistorization

The use of vacuum tubes has all but disappeared. Transmitters, receivers and control circuitry are all transistorized. This approach has increased reliability, reduced battery drain and reduced the over-all weight of control equipment. In fact, without the use of transistors much of the new proportional control equipment, which will be described later, would be completely impractical. Silicon transistors have been used extensively because of their ability to operate over wide temperature variations. Integrated circuits are beginning to find application in the newest commercial equipment. Since rc equipment must work outdoors, it has this handicap to overcome as well as the other more obvious environmental hazards such as vibration and shock.

Fig. 1 is the circuit for a single channel transmitter developed by Dick Jansson. A commercial version of this unit is available

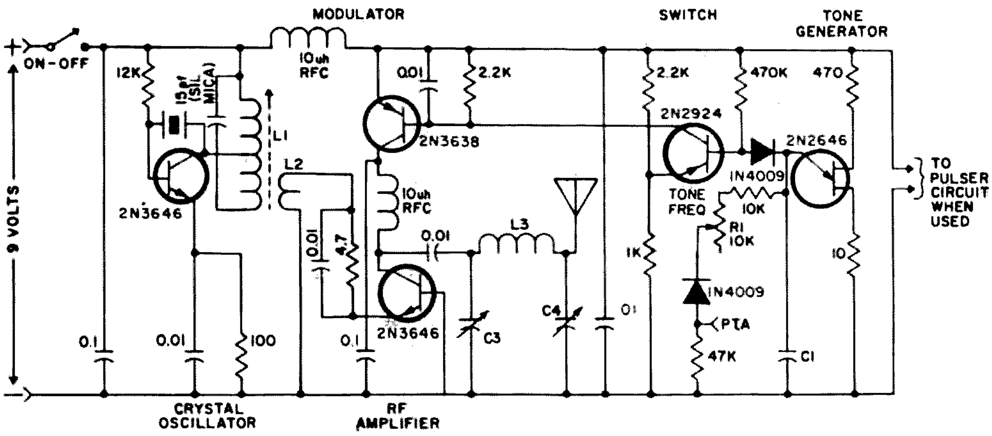


Fig. 1A. Basic transmitter with tone modulator. All resistors are ½ watt; capacitors are disc ceramic in uf unless marked.

L1—8¼t, #26, tapped 4 1/8 from +9V CTC form #2173-3.
L2—2¼t, #26 over center of L1.
L3—4t, #20, ½ dia. self-supporting.
Crystal—50 mhz, 3rd overtone.

C3—ARCO 423 (100-7 pf)
C4—ARCO 422 (40-4 pf)
Antenna—50 inch whip (approx. length)

C1	Tone Freq. Range
0.082	450-900 cps
0.047	800-1600
0.027	1400-2600
0.015	2500-4400

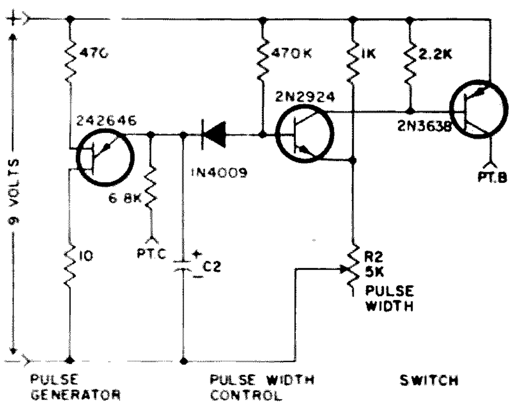


Fig. 1B. Pulser circuit.

C2	Pulse Freq. Range
8 µf	7.5 - 20 pps
6	10 - 27
4	15 - 40

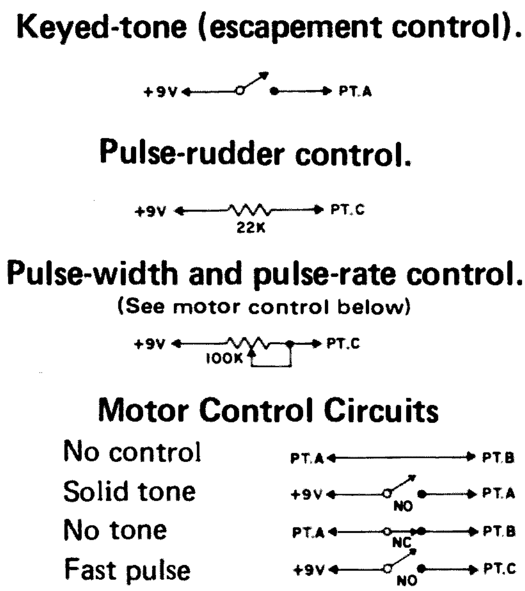
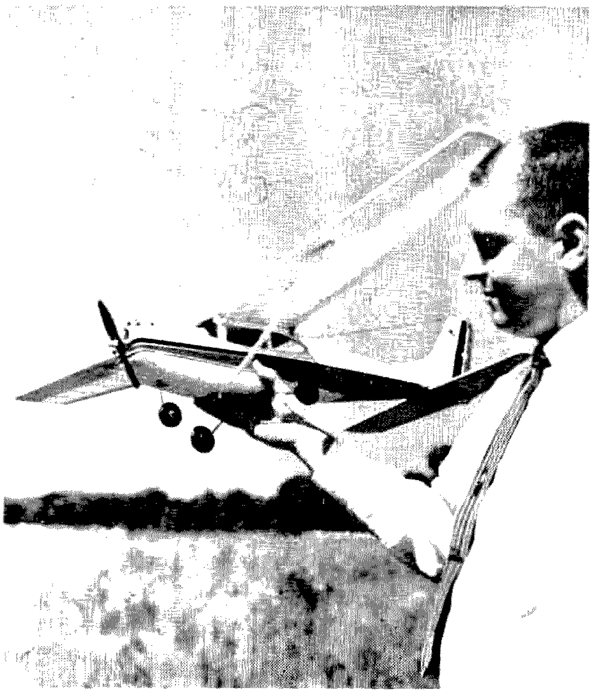


Fig. 1C. Control circuits.

Fig. 1. Six meter single channel R.C. transmitter.

from Ace Radio. This circuit provides for two basic modes of control: Escapement control and pulse-proportional control. The *rf* section and its modulator are all that are necessary for escapement control. The pulse control circuits may be added to provide control of modulation pulse-rate and pulse-width. In the latter case, the absence of pulsing, extra fast pulsing, or continuous tone modulation may be used for additional control(s). The following system has been used many times:

Control Function	Control Signal
Rudder	Pulse width (20 to 80%)
Elevator	Pulse Rate (5 to 30 cps)
Motor Speed	Continuous tone or absence of tone.



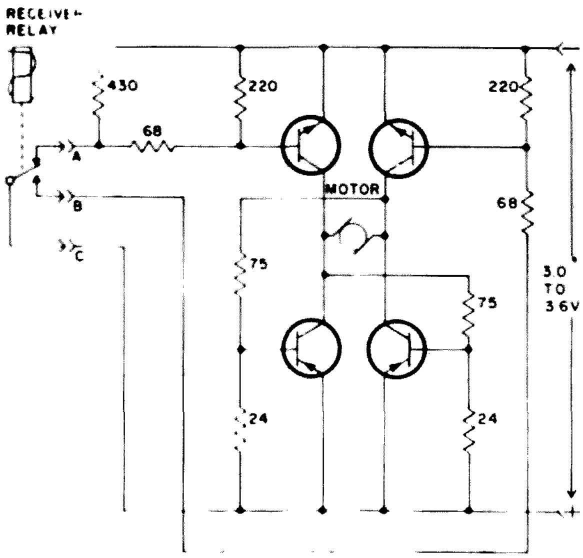
Scale R.C. model of Cessna Skylane built by Roger Carignan, W1NRO. A simple pulse-proportional control system is used in this model with a switching circuit designed by Roger and shown schematically in Fig. 2.

Developments in Simple Pulse Proportional Control

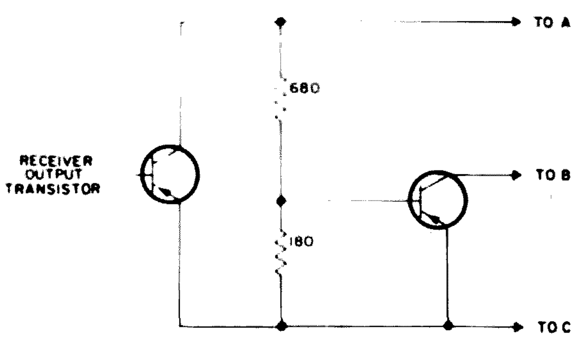
Since the previous article was written there has been a rebirth of interest in simple pulse proportional equipment. The merits of this system from a cost standpoint are immediately obvious when compared with multichannel proportional equipment cost. Its major disadvantages are: 1) The relatively high (and continuous) current required by the actuator (servo) in the airplane and 2) the fact that the rudder and elevator surfaces continuously vibrate back and forth. The vibrations may cause the airplane to noticeably

weave up and down or left and right. This has given rise to this type of control being known as the "Galloping Ghost" system.

Several "Galloping Ghost" or pulse-proportional actuators are now available that allow push rod connections to the control surfaces. Previously, these connections were made using an oscillating torque rod from a simple actuator to a motion-sorting linkage that was exposed at the tail end of the airplane. The exposed linkage was very vulnerable to damage and gave the appearance of a mousetrap (bat trap?) hanging onto the rear of the model. The use of low impedance nickel-cadmium batteries is essential in this system. Transistorized switchers are becoming more prevalent. These allow the use of one set of batteries in place of the balanced negative and positive supplies previously used. This approach saves battery weight[2] and assures that balanced control occurs in both directions (left/right and up/down) as the battery discharges. Transistors can also be used to replace relay contacts for added reliability. Fig. 2 is the circuit for a pulse proportional switcher developed by Roger Carignan, W1NRO. This switcher is used in Roger's Cessna Skylane model shown in one of the pictures accompanying this article.



Switcher circuit for pulse actuators that eliminates the need for both positive and negative batteries.



Relay eliminating switcher for use with switcher circuit shown above.

Fig. 2. Pulse control switcher circuits. All resistors are ½ watt. NPN transistors are type 4JX11C1847 (GE). PNP transistors are type 4JX1C1132 (GE). Motor is permanent magnet type with armature resistance greater than 6 ohms.

Seen one lately? This flying saucer is real. It is radio controlled and performs very well with a galloping-ghost proportional control system. This off-beat project was undertaken by W1OLP, writer of this article.

Improvements in Single Channel Servos

In the area of escapement control there have also been notable changes. In fact, the term escapement control is no longer generally correct since most single channel "escapement control" is now performed using electrically driven "servos" rather than rubber band driven escapements. Several excellent single channel servos are now available and have eliminated the hazard of forgetting to wind the escapement rubber before a flight is begun. Single channel servos work in a manner similar to their predecessors; an electric motor and a battery have replaced the rubberband. A continuous signal causes the actuator arm to move 90 degrees. When the signal is stopped the arm moves in its initial direction until it stops at the 0 degrees position. A signal like an "A" in CW with the dash held, will move the arm through the 90 degrees position and cause it to stop at 270 degrees. Interruption of the dash part of the "A" will cause the arm to return to 0 degrees.

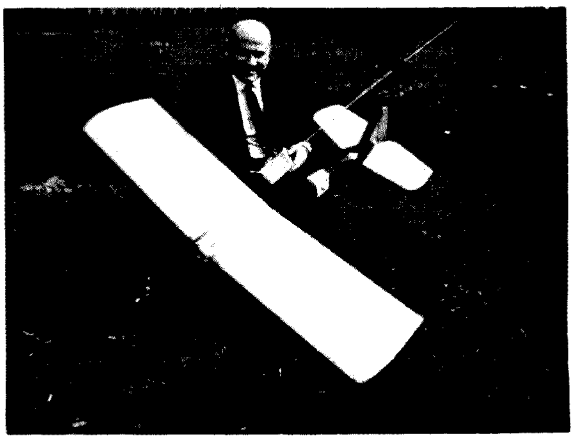
2. For equal battery life the basic weight of the battery is the same except for mounting hardware and wiring which is equalized by the switcher's weight.

A third position is attained by sending a "U" with the dash held. This stop occurs at about 350 degrees. The 90 degrees position is used for right rudder; the 270 degrees position gives left rudder and the 350 degrees position gives negligible rudder movement but actuates a switch in the servo which can be connected to an auxilliary servo that controls the throttle. Note that the third position (350 degrees) switch is fed from the back contact of the control relay in the receiver. In this way the auxilliary servo is actuated only when the third position is called for and not when the arm passes through this position on its way back to neutral (0 degrees). A number of systems exist for getting more control functions from single and "cascaded" compound escapements.

Single channel servos are more expensive and are heavier than an equivalent rubberband escapement system. However, they tend to be more reliable and to perform their appointed task over long periods of time without adjustments. Rubber driven escapements have shorter life and take some tinkering to keep them in top-notch condition.

Multi-Proportional Advancements

In 1963, essentially all multi-channel control systems used a series of tones selected by the pilot at the transmitter to actuate tuned reeds in the airplane. The reeds, in turn, actuated on-off servos that worked the control surfaces or other functions in the airplane. At that time "multi-proportional systems" existed, but only a few people gave them a chance for survival. Only the most enthusiastic supporter of proportional control would have predicted in 1963 that in five years it would replace the reed system which



Cliff Piper, WA1IEC, Academy of Model Aeronautics, District I, Vice President poses with his six channel reed system R.C. model. Cliff is a long time modeler and recent amateur radio enthusiast. He's active on 75 meters from his Atkinson, N.H. QTH.

had been the standard for many years.

Proportional control allows the pilot to position the control devices in the airplane to any position in proportion to the setting of joy-sticks, knobs or levers on the transmitter. Unlike escapement and reed systems which give full control (e.g., full-right or full-left) when control is called for, the proportional control system allows the pilot to give any partial amount of control action he desires. Additionally, this type of control inherently allows each control function to be "trimmed" as well as actuated. Rudder, elevator and aileron trim can be provided with no additions in the airplane and very simple additions in the transmitter. In a reed system trim for one function (e.g., elevator trim) requires an added servo in the airplane and two additional channels in the transmitter and receiver.

Unlike reed systems, proportional systems use joy-sticks in place of switches to initiate control action. There is considerable variation between systems in the number of sticks used and in what functions the motion of these sticks control. One of the most used systems employs a single stick. Back and forth motion controls the elevator: left and right motion controls the ailerons; and a knob on the top of the stick controls the rudder. Trim for the foregoing controls is provided by thumb-adjustments located on three sides of the stick. Motor speed and auxilliary controls such as flap position (when flaps are installed on the airplane) are controlled by other thumb-adjustments, levers or knobs located on the face or side(s) of the transmitter. Control of brakes on the left, right and nose wheels is obtained by tying them into the rudder and elevator or flap controls. Use of three separate brakes greatly improves the ground handling capability of a model airplane. Both mechanical and electric brakes are being used successfully.

Two basic control philosophies exist for proportional model control. Originally, proportional systems were of the "analog" variety. Later a so-called "digital" control approach was introduced and, today, is the most popular by far. The rudiments of both approaches are alike: A signal proportional to the desired control position is generated in the transmitter: this is used to modulate the transmitter's *rf* output: the receiver demodulates the signal and converts it to a voltage: and this voltage is used as the input to a closed-loop servo which actuates the control surface. Fig. 3 is a block diagram of the typical closed-loop servo. Those who have worked with servo-mechanisms will immediately recognize that this is a true "servo-mechanism" and can rightfully be termed a "servo." Previous usage of the term in the r.c. vocabulary has referred to a device which performs a similar function but in an open-loop manner.

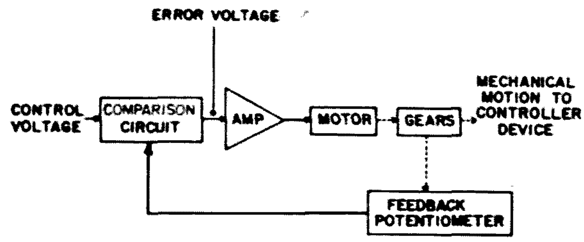


Fig. 3. The closed-loop servo shown in block diagram style in this figure is a major element in a fully proportional control system.

The motor in the closed-loop servo will run until the error-voltage is reduced to a low value. The error-voltage is generated by comparing the input-signal-voltage with a feedback-voltage. The latter voltage is obtained from a potentiometer or variable capacitor which is driven by the servo's output gear-train. It is a measure of what position the servo is actually in. If the input-voltage and the feedback-voltage are alike, the servo is in the correct position. If there is a difference, an error exists and the resulting error-voltage is amplified and fed to the motor which, in turn, goes in the direction necessary to correct the error. Fig. 4 illustrates the error voltage as a function of the mechanical (angular) error at the output of the servo. Note that a closed-loop servo will respond to changes in the input signal; i.e., it will make corrections until the output position agrees with the position called for by the input signal *and,* unlike open-loop systems, it will also correct for "load errors." A typical load error in model control system results from wind pressure on a control surface as it is moved into the airstream. If this pressure is large enough it will tend to neutralize the control position and the control becomes less effective. In a

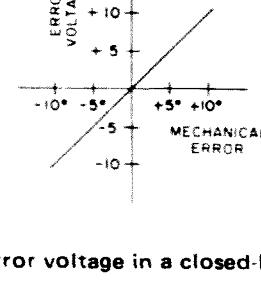


Fig. 4. Error voltage in a closed-loop analog servo.

close-loop servo the error caused by "blowback" of a control surface is recognized by the error detector and the servo motor operates to correct the error. Notice that this occurs without the need for the pilot to recognize the error and make changes in his command to the airplane.

A servo is needed for each basic function to be controlled in the airplane. They weigh between 1 and 2 ounces; they are roughly 1"x1½"x1½" in size; and they have seven to nine transistors in their amplifiers. Control action is relatively fast; no lag is perceptable between the pilots command, and the control response in the airplane.

Analog control signals are most often transmitted in the form of frequency variations. Discriminator circuits are used in the receiver to convert these variations into voltage variations. This method of transmission is independent of signal strength and is fairly immune to interference. "Digital" control systems use various forms of pulse-code-modulation and de-modulation to transfer commands from the transmitter to the servos. A discussion of the various systems used (or possible) and their relative merits is far beyond the scope of this article and, perhaps, is beyond the present state-of-the-art. Most

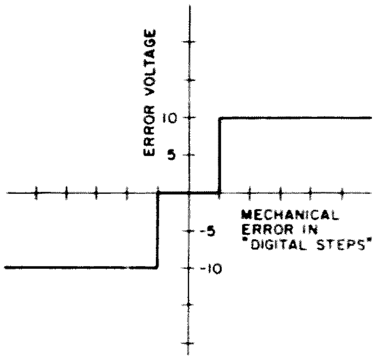


Fig. 5. Error voltage in a closed-loop "Digital" servo system. This curve is idealized.

digital systems use pulse-position modulation. Combinations of pulse-rate, pulse-width, and pulse-spacing are used in other systems to convey the needed information. When listened to on a communications receiver, the signals from a digital transmitter sound like a 19th-century music box programmed to play notes in a relatively unmusical order.

Digital systems have error-voltage characteristics like that shown in Fig. 5. This type of error characteristic causes relatively stiff control action for small errors and yet does not cause oscillation in the servo system. The analog system (see Fig. 4) generates an error signal that is proportional to the error and,

hence, has relatively soft control action when the error is near zero. When more gain is added to an analog servo to make it more stiff, it tends to oscillate (or "hunt") unless precision gearing or special control functions are included.

Many proportional systems include a "fail-safe" feature which prevents serious fly-away situations. In most cases, these features work on the basis of remembering when the last control signal was received from the ground. If no signal has been received for a preset length of time (generally set between 15 and 30 seconds) the motor speed is reduced to minimum and all controls are set to their neutral positions. These settings will normally cause a gentle descent and a landing within reasonable walking distance.

Proportional systems have two disadvantages. first high cost; and second, less immunity to interference than reed control systems. Interference problems are related largely to the "equivalent bandwidth" of the receiving system. In proportional systems "equivalent bandwidths" are wide because of the pulse type modulation used. In reed systems the bandwidths for each channel is about 30 cps: the reeds themselves being the limiting devices.

The cost of proportional systems run from $200 to $600 for the electronics including the transmitter, receiver, servos, and batteries. The $200 system is in kit form. The most preferred proportional systems are selling in the $300 to $500 range. Needless to say, it is important to investigate carefully before you decide "to go proportional."

Performance Records

Model airplane competition has been on an international scale almost from the inception of the hobby. The United States sponsors free flight, control-line and radio control teams that compete yearly for international honors. The United States radio control team has placed high in both an individual and a team basis for the past several years. Competitions are held every other year in Europe, which has made it necessary to subsidize the travel expenses of the competitors. The Academy of Model Aeronautics (AMA) has played a major role in this area as well as governing the competitions within the U.S.A. Chart 1 summarizes our performance in the 1967 International rc Championships. Phil Kraft, K6SQF, who took first place, is an amateur.

In addition to the world championships, a continuous world wide competition exists to extend certain specific records. These records are summarized in **Chart 2.** The Federation Aeronautique International (FAI) governs all record attempts and establishes the rules for each event. The FAI is the same organization that performs this function for full size aircraft records. This competition is a deliberate process that requires much from the competitor, himself, and a great deal from others who must act as witnesses and who must provide the precise measuring equipment required by FAI rules. The armed services, governmental agencies, educational institutions and private industry have been very cooperative in assisting individuals to establish new records.

COUNTRY	INDIVIDUAL PLACES
Austria	21, 30, 39
Belgium	15, 25, 27
Czechoslovakia	29, 36
Denmark	33
France	2, 12, 26
Germany	3, 5, 24
Great Britain	9, 23, 32
Greece	35
Holland	13
Italy	16, 20, 28
Liechtenstein	6
Luxembourg	37, 38, 40
Norway	19, 41, 42
South Africa	7, 11, 22
Sweden	14, 18, 31
Switzerland	8, 17, 34
United States	1, 4, 10

Chart 1. 1967 International r.c. Championship score summary. United States placed first both on a team and individual basis. Phil Kraft, K6SQF, is world champion.

Radio Control Frequency Considerations

Amateurs have a great advantage over those who are limited to Citizen's Band frequencies for r.c. activity. Chart 3 lists the CB and amateur radio control frequencies presently in use. The CB frequencies are shown here to indicate the type of competition amateurs may expect from CB rc enthusiasts. Note that very few 27 mhz CB rc transmitters and no 72-75 mhz CB r.c. transmitters exceed 1 watt input to the final stage. Even in the face of interference where high power transmitters and low sensitivity receivers are in order, no trend toward higher power has occurred. The use of selective superheterodyne receivers has solved most of the CB rc interference problems. With 1 watt input there

RADIO CONTROL RECORDS FOR MODEL AIRCRAFT

(As of February 1, 1967)

EVENT	RECORD	HOLDER
ALTITUDE		
Powered	16,610 ft.	Northrop, USA
Glider	3,660 ft.	Hill, USA
ENDURANCE		
Powered	8h, 52m, 25s	Hill, USA
Glider	11h, 33m, 28s	Smith, So. Africa
SPEED		
Powered	140.28 mph	Hill, USA
Glider	29.5 mph	Hahn, USA
DISTANCE (Straight Line)		
Powered	184.146 m	Hill, USA
Glider	10.39 m	Malikov, USSR
DISTANCE (Closed Course)		
Powered	173.89 m	Piston, USA
Glider	43.55 m	Colver, USA

Chart 2. The records listed in the chart are those recognized by the Federation Aeronautique International (FAI). The FAI is the organization which governs and records all international aircraft records. It has headquarters in Paris, France. Since this chart was compiled, many of the records shown have been broken. Typically, the altitude record is now in excess of 19,000 feet.

is no practical limit to the range that may be obtained. Recent high altitude flights have gone to over 19,000 feet with no loss in reliability. At distances over 1,000 feet in the normal rc case, the model becomes difficult to see: spirals (or spins) to the right cannot be

distinguished from their left-hand equivalents. It is generally agreed that long, reliable battery performance is much more advantageous than extra range which is never used.

Amateurs will no doubt choose frequencies in the line-of-sight bands to preclude regular interference from dx stations. Choice of the uhf's has other advantages, the most important being freedom from local interference. Even the uhf bands that are most used are quiet during the daytime when most r.c. activity takes place.

Maiden flight tension shows as Bob Fish starts the take-off run of Charlie French's "Duster" biplane. Bob and Charlie are typical radio controllers who operate on CB licenses.

All amateur frequencies above 51 mhz, with the exception of 147.9 to 148.0, are legal for AØ and A2 emission. AØ is defined as the "absence of modulation" and A2 is tone modulation. A2 is legal as low as 50.1 mhz, but the question of call signing becomes an interesting one. In any case, for interference reasons, operation below 51 mhz is not desirable the bulk of all amateur communications on six meters is at the low frequency end of the band. The high end of the six meter band is most attractive. The author has operated for years at 53.4 mhz with superregenerative receivers. No interference has been experienced from a channel 2 (54-58 mhz) television station located within 5 miles. No amateur interference has been experienced. Some difficulty has been experienced with harmonics of a 5 watt CB transmitter when using a highly sensitive transistorized superregenerative receiver. CB channels between 26.965 mhz and 27.005 mhz have second harmonics in the range of 53.930 mhz and 54.010 mhz. This range includes the popular 26.995 mhz r.c. channel. Because of potential harmonic problems from local CB stations, and possible overload from television channel 2, the extreme top of the six meter should be avoided.

Citizen's Band R.C. Frequencies

27 MEGAHERTZ BAND

26.995 mhz
27.045
27.095
27.145
27.195
27.255*

1. Class "C" CB license required**
2. 5 watts input maximum
3. .005% frequency tolerance
4. Shared with other r.c. users

* 30 watts input maximum; shared with CB voice (Class D).

** Less than 100 mw; transmitters do not require licenses.

72-75 MEGAHERTZ BAND

72.08 mhz
72.24
72.40
72.96
75.62

1. Class "C" CB license required
2. 1 watt input maximum
3. .005% frequency tolerance
4. Exclusive for model rc users

Amateur Band R.C. Frequencies

Band (meters)	Frequency Range (mhz)
6	51 to 54 mh
2	144 to 147.9
1.4	220 to 250
0.7	420 to 450

Chart 3. This chart summarizes the frequencies available for r.c. model use.

As the bands get more crowded and good equipment for the higher uhf bands becomes more available, the two and 1.4 meter bands may become more popular for rc. Several years ago, CB rc equipment was available on the 450 mhz band. The receivers in this equipment used crystal detectors followed by high gain audio amplifiers. The transmitters used conventional uhf self-excited modulated oscillators. This equipment, though crude in many respects, enjoyed a fine reputation for reliability.

Tuning difficulties may limit the practical use of the superheterodyne to frequencies below 100 mhz. The frequency of rc superhets is most conveniently controlled through

use of a crystal controlled oscillator. Matching the transmitter's frequency with that of the receiver is a subject that bears special consideration. This problem is presently being faced by those designing equipment for the new 72-75 mhz CB frequencies. In diagram form, the problem is shown in Fig. 6.

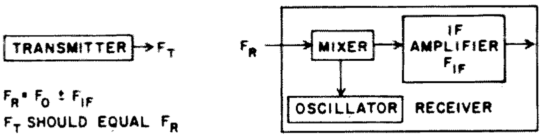


Fig. 6.

Ideally, the transmitter frequency (F_T) must be exactly equal to receiver frequency (F_R). With 5 khz receiver bandwidth and transmitter modulation frequencies of about 1 khz, the practical case allows about 2 khz variation between F_T and F_R (see Fig. 7). This permissible variation is very little when we consider temperature, vibration, aging, and the other factors which tend to detune the system.

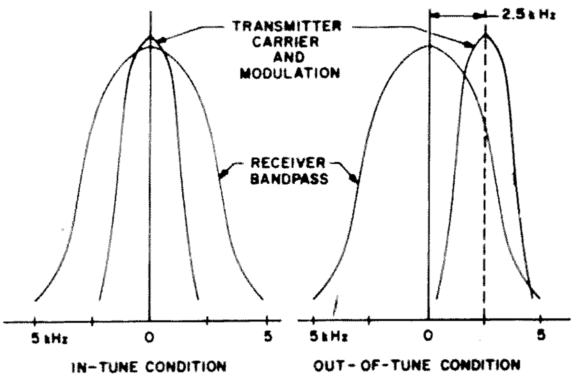


Fig. 7.

If a bandwidth of 5 khz and a fixed intermediate frequency is assumed, the transmitter must have a frequency tolerance from a known receiver frequency of:

$$\frac{\pm 2 \text{ khz}}{50{,}000 \text{ khz}} = \pm 0.004\%$$

The important factor here is that the receiver frequency must be known accurately. If the receiver crystal has a marked tolerance of 0.005%, in any circuit other than the one it was designed for, it may have twice the marked tolerance. A typical 50 mhz crystal may then be:

$2 \times \pm 0.005\% \times 50{,}000$ khz $= \pm 0.0001 \times 50{,}000$ khz $= \pm 5$ khz away from its marked value of frequency. If the *if* frequency is off ± 3 khz and is not tunable, the receiver may be tuned as much as ± 8 khz from the chosen spot. With this sort of frequency separation between the transmitter and receiver range

can be reduced greatly.

If the if frequency is tunable, it can be adjusted to compensate for the misalignment between the transmitter and receiver frequencies. If the if is not tunable, you have a real problem since the two crystals (reciever and transmitter) are the only practical variables. Generally you can "pad" crystals by adding capacity across them (or inductance in series) to get a maximum of about 2 khz change in frequency at 50 mhz before crystal activity is seriously affected. The addition of parts to the receiver is not a practical solution because of space problems. The transmitter crystal can be padded, reground, or "weighted" by someone experienced in the business of shifting crystal frequencies. Another approach which may not be too "far-out" is the use of a variable frequency oscillator (vfo) in the transmitter. A vfo might have to be adjusted regularly, but certainly should hold its adjustment through one flying session if the transmitter were handled carefully and the vfo were well designed.

The most practical solution for the amateur is to use superregenerative receivers. Under present band conditions they provide enough selectivity, high sensitivity and excellent reliability.

Conclusion

Estimates of the number of people involved in the radio control hobby vary widely since there are no good ways of counting heads. It is safe to say that interest is increasing rather than decreasing. The increase is evident from the observation of the rc equipment that is being successfully marketed, from the fact that a new slick paper magazine devoted entirely to rc has been successfully published for over three years and from general interest in clubs, rc competitions and "Sunday flying" sessions. The increased interest should spark ever more interest.

John Ross, WA1BGP, was founder of the New England Radio Control Modellers. This group represents all the New England states, runs regional contests and helps formulate contest rules for the whole country. Many similar groups exist throughout the United States and in other countries.

From the correspondence we have had, we are convinced that many of those who have decided to take an interest in radio control have followed our advice; 1) to start with something simple, and 2) to find someone experienced in the hobby and listen carefully to his advice. Even the experts have their bad days when the Red Baron prevails and the wreckage is dismaying, to say the least. The experts add this sort of thing up to experience and are back in the air quickly. On the other hand, many novices end their interest after a disappointing first visit to the flying site. Most of these failures could be avoided if the novice enlisted the help of an experienced rc fan before he attempts his first flight. Again, happy landings!

...W1OLP

Appendix

This appendix includes material for those who wish to find out more about the rc hobby. Clubs, books and periodicals that provide more detailed information are covered.

Clubs

Local clubs can be located by contacting a hobby shop that caters to model-airplane hobbyists.

Nationwide, the Academy of Model Aeronautics, 1239 Vermont Avenue, N.W. Washington, D.C. 20005, is the ARRL of the model-airplane hobby. Membership in this organization includes insurance coverage for damage that may be caused by the member's model airplane.

Books

DCRC Technical Symposium Papers, published yearly and available from AMA Supply and Service (see address under clubs). The serious rc fan will find these papers most useful. They are on a generally higher technical level than other available literature. Cost is about $2 per year; back issues are available.

How to Build R/C Models, by William Winter, Kalmbach Publishing Co., Milwaukee, Wisconsin, 2nd printing, 1962.

Radio Control Handbook (revised edition) by Howard McEntee, Gernsback Library No. 93 ($4.95).

R/C Primer (2nd Edition) by Howard McEntee, Kalmbach Publishing Co., Milwaukee, Wisconsin, copyrighted 1964.

Model Airplane News R/C Digest published by Air Age, Inc., 551 Fifth Ave., New York, N.Y. 10017 ($2).

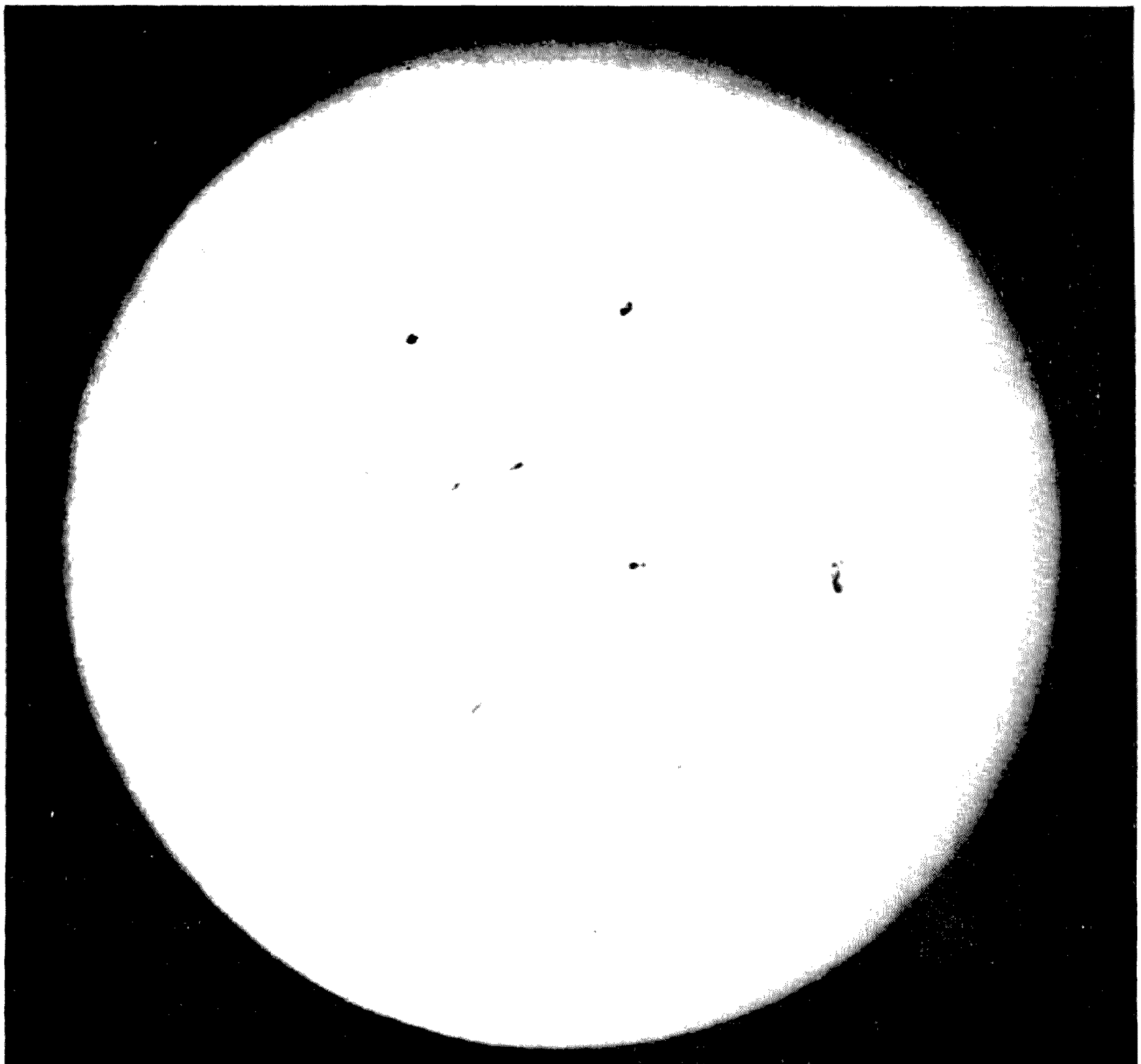
Periodicals

American Modeler, published monthly by Potomac Aviation Publications, Inc., 1012 Fourteenth Street, N. W., Washington, D. C. 20005. Howard McEntee, Radio Control Editor. This publication includes the official publications of the AMA.

Flying Models, published monthly by Rajo Publications, Inc., 85 Canisteo St., Hornell, N.Y. 14843. Maynard Hill, Radio Control Editor.

Model Airplane News, published monthly by Air Age, Inc., 551 Fifth Ave., New York, N.Y. 10017. William Northrop, Radio Control Editor.

Radio Control Modeler, published monthly by R/C Modeler Corp., P.O. Box 487, Sierra Madre, California 91024. Don Dewey Editor. Devoted entirely to radio control modeling.



Official U.S. Naval Observatory Photograph

Long-Range Propagation Forecasting

J. H. Nelson
157 Fernwood Terrace
Garden City, New York 11530

It is necessary that my propagation forecasts to the editor of 73 Magazine arrive two months ahead of publications. The forecast is for a full month and therefore must cover a period beginning 60 days away and ending 90 days away. Several amateurs have asked me how it is possible to make forecasts of something so whimsical as a radio disturbance so far in advance. I do this by using the angles that separate the sun's planets as they circle it on a day-to-day basis.

It is not common knowledge, but some daring astronomers of over a hundred years ago suspected that the planets were in some unknown manner related to the formation of sunspots and also to the well-known 11-year sunspot cycle. They researched the subject and produced statistical evidence that strongly indicated there was a connection between sunspots and planets. Unfortunately, in spite of the evidence supporting this theory, the leading astronomers of the world took the stand that the planets were too small and too far away from the sun to affect it. For that reason, this theory really never got off the ground and is, to this day, not accepted by leading astronomers. The astronomers themselves are still trying to develop a more acceptable theory that would explain both the sunspots themselves and their cyclic behavior. Incidentally, there are several cycles in sunspot numbers but the 11-year cycle is the most well known.

My career in radio began in 1923 with RCA in New York as a long wave radio operator. In 1930 I was changed from operating to supervising duties in the then new field of short wave radio. I continued supervisory work until 1946 when I was assigned to sunspot research. In an attempt to develop a short wave radio disturbance forecasting technique based on the study of sunspots, I used a six inch telescope mounted on the roof of the Central Radio Office in downtown New York. Astronomy books stated that sunspots caused poor shortwave radio signals.

After three years of intensive study comparing daily sunspot behavior to daily short wave signal behavior, it became apparent that sunspots per se were not the full answer to the problem. There were many cases in which the sun would be covered with spots from the eastern edge to the western edge in a belt 15 degrees to 20 degrees each side of the equator and accompanied by good radio signals. There were other cases in which the sun would be completely devoid of spots and accompanied by poor signals night after night. Such a situation was intolerable to a forecaster.

This was strong evidence that some other forces were also at work here. I decided to follow in the footsteps of the early astronomers and see what could be produced from a search for possible planetary effects upon sunspots and our ionosphere.

Back tracking through five years of radio signal quality records and comparing each day with the angular separation of the planets each day showed a very strong correlation between certain angles and disturbed conditions.

The analysis comparing short wave signal qualities and planetary angles made between Mercury, Venus, Earth, and Mars (the inner planets) to other planets farther away from the sun than they were showed that disturbed conditions began close to the time (usually plus or minus one day) when there was a 0 degrees, 90 degrees, or 180 degrees separation angle existing between one of the inner planets and more distant planet. Therefore, these angles were selected for special research attention and referred to as significant angles.

The analysis showed that there were more of these significant angles than there were disturbances, however, and this would cause a forecaster to call for too many disturbances. Further analysis showed that the best correlation existed between disturbances and planetary configurations of a multiple type and the closer a configuration came to being a multiple, the greater chance of a disturbance.

In a multiple configuration one fast inner planet will make a significant angle with two outer planets while the two outer planets are themselves at a significant angle. An example would be Mercury 180 degrees from Venus while Mercury and Venus are both 90 degrees from Saturn. There are three other forms of multiples, such as two planets at 0 degrees while a third is 90 degrees from each, two planets at 0 degrees while another is 180 degrees from each, and three planets all 0 degrees at the same time.

These special multiples do not occur very often and their use reduced the tendency to call for too many disturbances.

Single contacts of 0 degrees, 90 degrees, and 180 degrees are also accompanied by disturbed conditions at times. Solving this problem was somewhat more difficult but when smaller angles were studied it was found that

sub-harmonics of 90 degrees were also important.

The sixth sub-harmonic of 90 degrees is 15 degrees and the fifth is 18 degrees. Study of the disturbance producing single contacts of 0 degrees, 90 degrees, and 180 degrees showed that there would also be present at the same time several angles to other planets that were some multiple of 15 degrees or 18 degrees from the fastest planet during the same day. The planets all have different velocities as they circle the sun, Mercury of course having the greatest.

One example of this type of configuration would be Mercury to Jupiter 90 degrees, Mercury to Venus 45 degrees, Mercury to Uranus 18 degrees, Mercury to Mars 72 degrees. There are, of course, several other arrangements of planets that would fall into this category. The main consideration is that the arrangement satisfy the single 0 degrees, 90 degrees, or 180 degrees set-up along with several simultaneous harmonics.

On the evening of March 23rd this year, there was a spectacular aurora accompanied by poor radio signals and a major magnetic storm. The forecast for this event was mailed to 73 late in December.

The arrangement of the planets in this case was a multiple configuration involving the Earth, Jupiter, and Uranus all at 0 degrees, that is, in a straight line to the sun. Also, there was a second arrangement of Venus and Pluto being at 0 degrees while 135 degrees from Mercury. Bear in mind that the Sun is always at the center of this circle. The position of the planets is given in what is referred to as Heliocentric Longitude in The American Ephermeris and Nautical Almanac published by the U.S. Naval Observatory.

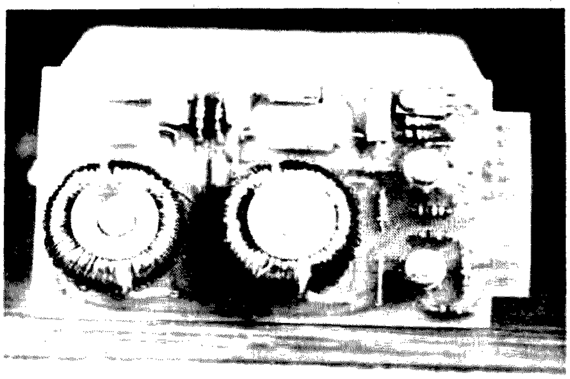
The research conducted at RCA Observatory since 1946 confirms beyond any reasonable doubt that the planets do influence the tenuous electrified gases in the solar atmosphere.

. . .J.H. Nelson

HELP STAMP OUT MENTAL HEALTH SUBSCRIBE TO 73 *NOW*

A Simple, Effective RTTY Terminal Unit

C.W. Andreasen, WA6JMM
Engineering Technician
Stromberg Datagraphics, Inc.
San Diego, California 92112



I have been experimenting with amateur radio Teletype for several years and during that time have come to the conclusion that a new design is needed to update the terminal unit. The two most popular units used are the military surplus converters, which are hard to come by at best, and the "Twin City" type TU, which is shown in the ARRL's handbook. Working in electronics, and doing a lot of transistor work, I thought I would try my hand at coming up with a better way. Over a period of several months, I built up units of different designs which worked with varying degrees of success.

In my testing, I would work my good friend WA6CFA, John Cullings on the two meter band. Laguna Beach is about 90 miles north of San Diego, my location. This made a pretty good test, since signals were not the very strong, noiseless, local type. I got John interested in the subject and he started working in the same direction, only he felt that an analog approach would prove superior to the digital line I was following. To make a long story short, he won and came up with the basic design for this unit which I am presenting. We have both put much time in on this unit and have found it, even in its most basic form, to out-perform just about any unit short of very sophisticated gear.

The basic unit consists of four functional blocks: the isolation amplifier, ratio detector, the voltage comparator, and the high voltage switch. The isolation amplifier and the voltage comparator are both low cost integrated circuits, whose use keep the cost of this unit to a minimum.

The secret of this terminal unit is in the UA-710 integrated circuit. The "710" is a high gain, high speed voltage comparator. Its operation can be summed up by stating

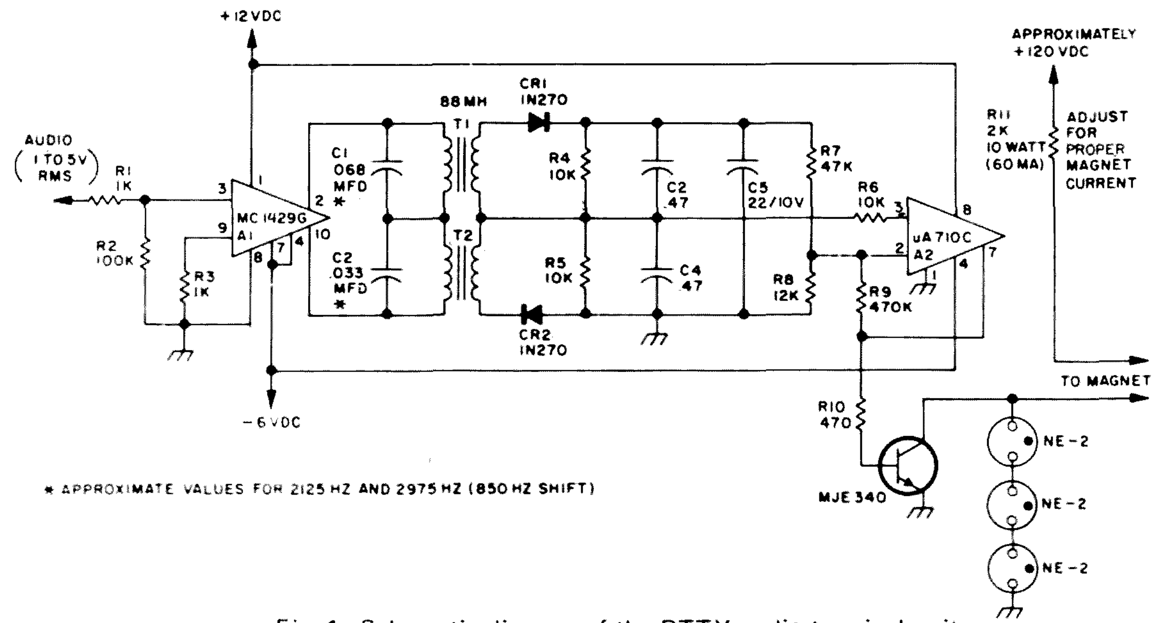
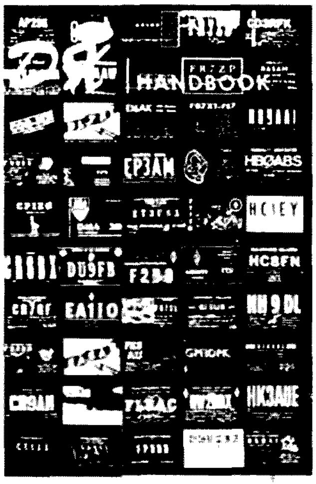


Fig. 1. Schematic diagram of the RTTY audio terminal unit.



that a reference voltage is applied on one input and the signal in question is applied to the other. Any time the incoming signal is greater than the reference, the output is in one state, and when the signal drops below the reference point, the output will switch to the other state. There is a very narrow threshold which gives this unit its extreme sensitivity.

The detector portion of this TU is a ratio detector, such as is used in an FM receiver. This type of detector is very insensitive to amplitude modulation which allows the FM (FSK) to be detected when it is down in the noise.

The incoming detected signal is integrated across C5 which is divided by R7 and R8 to form the reference voltage for the comparator. Since this voltage is proportional to the detected signal, it automatically tracks and eliminates the need for a variable reference control.

T1 and T2 consist of the standard 88 mH toroid telephone chokes which are available surplus or as advertised in the back of this magazine. They have been modified into transformers by the addition of 50 to 100 turns for a secondary. The number of turns used is not at all critical, as long as the same number of turns are on each transformer. My unit has 100 turns, while the one built by WA6CFA has only 50; both units work equally well.

A-1 is used as an isolation amplifier to drive T1 and T2 differentially, and is no more than a Darlingtor differential amplifier. Two different units were tried with good results. I used the Westinghouse "WC115" since it cost less than the MC1429G, but either unit can be used if attention is paid to the different pin connections.

The output keying transistor is a high voltage type, so the standard 150 volt loop supply could be used. Again, most any type of high voltage transistor can be used, but I recommend the MJE-340 which Motorola sells for around $1.00 and can handle the power easily. The neon bulbs are a must to protect the MJE-340 from kick-back spikes.

Layout is not at all critical and modifications are easily added for tuning indicators, reversing switches and the like. I might add that the best way I have found to put in a reversing switch is to switch the "hot" end of C1 and C2 between respective places. Wired as shown in Fig. 1, the mark frequency is 2125Hz, with space being 2975Hz.

In buying the IC's, I would recommend

that the Fairchild 710 be purchased since it can be obtained for approximately $3.00, which is less than the other makes.

With this unit, very narrow shifts are possible. I am able to copy a 200 cycle audio shift when it is below the noise level and voice communication is impossible. Narrower shifts should present no problem. I have not tried a shift of less than 200 Hz, but with the proper selection of values for C1 and C2 there is no reason it would not work somewhat narrower.

Exact shift frequencies are not manditory for copy since the ratio detector is an FM type of detector. If the received station's tones are a bit off frequency, you probably will not notice any increase in error rate unless the received signal is very weak or the tones are considerably off frequency. The operation of this unit can be vastly improved when utilizing narrow shift, by the addition of a good audio bandpass filter, designed for the shift in use, between the receiver audio output and the terminal unit input. If the signal being copied fades below copy level, or there is no signal at all, the Teletype machine will not run open; it will sit quietly until a proper signal is tuned in.

...WA6JMM

"It just now occured to Frank that he met his wife through the ham equipment they sold him!"

Bill Hood, W1USM
229 Quincy Shore Drive
Quincy, Maryland 02171

Facts and Fads

I once heard our illustrious hobby defined as "that class of individuals who, by demonstrating a certain degree of achievement in radio techniques and principles, have earned the privilege of playing with the air waves," and while I know a few guys will get a bit huffy over such a definition, I frankly like it. True it may be that our hobby has contributed much in the way of the development of the arts, but it always has been with the idea of pleasure, foremost, and when it becomes otherwise, we will no longer be amateurs. The very word, "amateur," comes from the French amator meaning one who loves. If you find pleasure in the art, that is, if you love the art, you are an amateur in its truest sense. (Just in case you're interested, the word "ham" was first applied to amateur actors. They couldn't afford to buy professional make-up, so they made their own out of hamfat.)

Strange as it may seem, most sciences were first explored by pleasure-seekers, or amateurs. For example, gunpowder was first invented for fireworks displays. The Chinese had little interest in its destructive power. Optics developed from the enjoyment of the light-scattering effects of irregularly shaped pieces of glass. Last of all, for many centuries, electricity was valueless except as a plaything. The early experimenters, in their course of discovery, some for pleasure and some for constructive purposes, stumbled through a comedy of errors as funny as anything that ever graced a ham actor's stage.

As far back as 700 BC electricity was known by the early Greeks. A scientist named Thales of Miletus commented on the peculiar property of amber. Amber is a glass-like, yellow stuff which, so they say, is petrified pine-sap. When briskly rubbed, amber would mysteriously draw other substances toward it, where they would remain for a while and then fly away. As men will do when they can find no other explanation, Thales credited the supernatural. These materials had a soul—they were alive. The soul of the amber drew them as if with a sucked-in breath. They flew away as the spirit exhaled! The Greek word for amber was "Elektron." Anyway, it was a beginning.

Throughout the dark ages little happened with this plaything. Experimenters were either jailed or burned as witches. But by the 17th century, hams were at it again. Once Gilbert had listed the various "electrics," or materials showing electrical characteristics, and Von Guericke had built a static generator, the clowns took it from there. In 1743, a Frenchman named Dufay suspended a small boy from the ceiling and charged him up with a static machine in order to watch bits of dust and splinters, etc., fly up to him. Dufay and his partner Nollet delighted the French court with this trick, and by charging each other up and drawing sparks from each other's nose. It wasn't long before kids were being charged up all over the place.

Another popular fad was to load a pretty girl with a nice hot static charge and then let her sweetheart kiss her! In 1745, Professor van Musschenbroek and a pupil were conducting an experiment in Leyden, Holland. They were seeking a way to store electricity, which by that time was thought to be a fluid (origin of the expression, "juice"). The good professor had his student hold a jar of water in one hand while an electrical charge was fed into the water through a metal conductor. After a while, the student touched the conductor with his free hand and nearly got knocked on his can. He didn't know that he had formed a capacitor with the water as one plate, his hand as the other plate, and the jar as the dielectric. He holds rather doubtful honor of being the first person to be socked by a loaded capacitor. Van Musschenbroek offered the theory that his "Leyden Jar" condensed the electric fluid, hence the use of the word "condenser."

Van Musschenbroek called his experiment terrible and frightening, and advised his friends not to try it, so they tried it. The jar was soon improved by using foil conductors inside and out, and shocks were "the

thing." Dufay's partner, Nollet was quick to pick up the idea. People swarmed into Paris to experience his shocks. It was a real fun idea. Nollet made a whole company of the king's guards jump simultaneously. He visited a monastery and zapped a line of monks three kilometers long. The idea soon came out that no matter how long the line of people was, they still jumped all at the same time. This electric stuff traveled awful fast.

So, Leyden jars were the "in thing." They were built into canes as a handy weapon, or practical joke, whichever was preferred. It was noticed that the shocks could kill small animals, or start fires in ether and alcohol. It was sensational. A hundred years later the Leyden jar was still the object of much speculation. In *20,000 Leagues Under the Sea*, Jules Verne had captain Nemo killing sharks with miniature Leyden jars. (Under water, no less!)

I'm getting a bit ahead of myself. It had been noticed that small animals, killed by a Leyden jar, would, upon dissection, show the same symptoms as if they had died during a lightning storm. Could there have been a connection? Then came Ben Franklin.

It's generally agreed that Franklin took a tremendous chance of being knocked tail over teakettle when he performed his famous kite experiment. Of course, Ben didn't know that. How often ignorance of danger can look like courage. Giving credit where it's due however, Franklin did not fly his kite with a wire for a string, as some people think. In the first place, there wasn't any wire around in his time strong and light enough to do the job. A wire thick enough not to snap would have been so heavy the kite would never have gotten off the ground. He used a piece of wet hemp string as his conductor, while he held it by means of an insulating silk cord. He still took a heck of a chance.

While we're on the subject of Franklin, I might mention in passing that he gets credit for naming positive and negative polarity, and defining them just the opposite as they actually are. (Positive should imply an excess not a shortage.) His odds there were 50:50, but he just didn't luck out. I guess he used up all his luck with the kite where he needed it.

Out of this came the lightning rod. I have a picture before me that I wish was not copyrighted, so the editor could only re-

produce it. It shows a man holding an umbrella with a lightning rod on top, and a long wire trailing off along the ground. I'd like to see the next scene.

In St. Petersburg, a Professor Richmann connected a lightning rod to a metal sphere in his lab, ungrounded. He got too close during a storm and was instantly killed, science's first electrical fatality.

When Galvani's wife had the tar scared out of her by a pair of frog legs that jumped without having the rest of the frog attached, (around 1786) there began a great deal of speculation that electricity might be the secret of life itself. Scientists began to toy with the idea of electrical cures for crippling diseases. Many an unfortunate cripple was wired up to various wierd and wonderful machines, and watched hopefully as limbs hitherto immobile kicked convulsively. In 1818, a condemned murderer sold his body to some English scientists who sent powerful surges of current through it. This was perhaps the most gruesome experiment in the history of man. The corpse jumped, wiggled, gasped, moaned, squirmed, and even pointed a finger. Life, however, never returned. In 1886, New York State decided to try out the first electric chair. They fouled the job very thoroughly, and the victim was ghoulishly cooked. Ever since, the chair has been called the "hot seat."

Morse's invention of the telegraph in 1844 did not begin, as many think, with the words, "What hath God wrought?" That message was the first *official* message, and Morse had promised in advance to a lady friend that he would use it. Actually, the news of Henry Clay's nomination for president had been reported from Baltimore to Washington several days earlier.

Bell had his share of sport with his telephone. It has been said that when he demonstrated it from Boston to Salem, his audience at the Salem end were treated to hearing Bell's landlady bawl him out for being late with the rent. The emperor of Brazil, upon hearing a telephone for the first time jumped back and cried, "My God it talks!"

Edison made many an invention for his own convenience. He had made a profound impression when, as a rookie telegrapher, he was "initiated" by the old timers. For two hours the fastest boy on the line whooped it up, and Edison copied solid. Finally he opened his key and signalled, "Send with other foot." In spite of first impressions he did finally get himself canned. He was on the night shift, and required to send out a recognition signal (to prove he was awake) every hour. He doctored up a clock and connected it to the line, and his signal went out automatically. The boss got suspicious, however, when he failed to get an answer just after the hourly check. He went out to the station and caught Tom sleeping like a baby as his machine faithfully ticked out its hourly check. To frost the cake, Edison when he was awake, carried on his own independent research in the station. One night he tried to get a little battery acid out of a large carbouy in the back room. The carbouy spilled over and the acid seeped through the floor where it made short work of the rug downstairs.

I could go on and on, but eventually it would get boring. In closing, let me just relate one more tale. The late Ernie Kovacs was famous for technical sculduggery on his TV shows. Nothing he did there could quite match his joke on a certain hospital staff when they examined his chest xray plate and saw the words, "out to lunch" in big black letters. Ernie had cut the letters out of aluminum foil and pasted them on his belly.

...W1USM

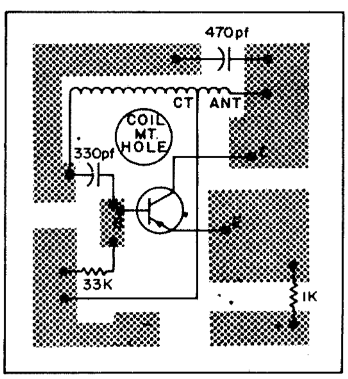
Super Simple B-F-O

Tunes S L O W and Stable Too.

Walt Pinner, WA8BHK
14657 Jenny Drive
Warren, Michigan 48093

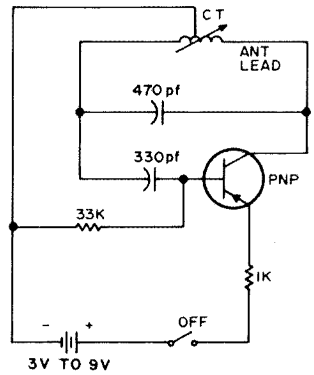
Have you ever wanted a small bfo to receive CW or SSB on one of the many multiband transistor portables which are available on the market today?

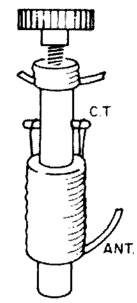
Many articles are available which state "Simply modify an old *if* transformer as follows, etc., etc." Attempts to remove the built-in capacitor or simply cut the unused and unnecessary winding from a miniature transformer is enough to drive a good man to drink. By the way, that drink doesn't help a large unsteady hand cut that elusive #42 wire from a small transformer with any less effort. Should you be fortunate enough to remove the lead without damage to the remainder of the transformer you usually find the tuning rate to be too fast to be practical if not just impossible.



Actual Size P.C. Board

The circuit described herein utilizes an inexpensive (39¢) Vari-loopstick. There are four additional Components and any pnp transistor gives sufficient signal that no direct





2.4 ma. drain @ 6 V.D.C.

coupling to the receiver is needed. Most replacement loopsticks are supplied with a small chrome knob and in this circuit two revolutions are needed to go through zero beat at 455 kHz. Therefore, adjustment of SSB or CW signals by changing the oscillator frequency is not at all critical in the event the tuning rate of your receiver is too fast.

Wiring is not at all critical; however, short rigid leads are desirable and should you elect to use the circuit board or a metal mounting plate the effects of hand capacitance when tuning will be eliminated. As a final precaution against instability due to the construction of the loopstick, I suggest coating the coil with paint or epoxy glue for rigidity. The PC board may be mounted to the bottom of the loopstick and the coil then inserted through a hole in the receiver case. Outboard operation is also possible by merely placing the bfo close to the receiver being used.

. . .WA8BHK/WB4MYL

An IC Audio Notch Filter

John J. Schultz, W2EEY/1
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Mystic, Connecticut 06355

A bridged-T audio notch filter combined with an IC amplifier produces a highly versatile, wide-range audio rejection filter with both variable frequency and variable "Q" controls.

Audio filters are certainly nothing new. They have long been used to improve the selectivity of a receiver or transceiver when it was not desired to "dig" into the *if* circuitry and improve the selectivity at the *rf* level. The disadvantage of such a method of selectivity improvement is that the selectivity takes place late in the receiver processing chain. Therefore, when one is listening to a weak station, a strong station near in frequency can control the avc or overload the receiver stages.

Nonetheless, audio selectivity is easy to apply and can take the form of either an audio frequency peaking or notching type function. Audio peaking can easily be provided by a number of fixed frequency filter designs and numerous inexpensive units are available from surplus outlets. The disadvantage of the peaking approach is that most filters which are of any real use produce a "ringing" effect. The sound is unnatural and definitely very tiring if the filter is constantly left in the circuit without any provision for disabling it. Stations can also be lost when scanning a band unless tuning is done very slowly when using the filter on CW.

The notching type filter, on the other hand, is usable on both CW and phone. It does not cause any ringing effect and does not mask any signals when quickly scanning a band. A single notch filter can only eliminate the one frequency to which it is set, but when a receiver already has a good phone filter – such as the multiple crystal or mechanical types found in SSB transceivers – one notch frequency possibility seems to suffice in most qrm situations. Audio notch filters built around passive components only are fairly old, but their use has disappointed many operators because to achieve reasonable narrowness and high attenuation at the notch frequency, expensive capacitors were necessary and the filter could only be used in very high impedance circuits. The use of an integrated circuit amplifier with a notch filter in a feedback arrangement, however, produces a notch filter of very high Q using inexpensive components. It is neither critical as to circuit impedance nor does it introduce any overall circuit insertion loss.

Basic Circuit

The circuit of the IC notch filter is shown in **Fig. 1**. The actual notch filter consists of the bridged-T network – the ganged 50 K potentiometer and the two .05 mf capacitors. The circuit presents a very high attenuation at one frequency which is related to the time constants of the circuit. The frequency of maximum attenuation can be changed by either changing the value of the resistive or capacitive legs. As was mentioned, however, unless special precautions are taken, the bridged-T network alone will tend to produce a very broad rejection notch which is particularly unsuited to CW work. The integrated circuit, however, corrects this situation in the following manner: the input signal passes through the bridged-T network to one input of a differential operational amplifier (a Motorola MC1533 in this case). Feedback through R4 is coupled from the amplifier output back to the signal input point. The other amplifier input (-) then receives a combination of the original input and feedback signals. Since the nature of a differential amplifier is such that when the (+) and (-) inputs receive equal level signals, the output is zero, R2 and R3 are chosen such that this condition exists and infinite attenuation takes place at the notch frequency.

There may be situations where a somewhat broader rejection notch is desired with correspondingly less maximum attenuation at the notch frequency. This adjustment is provided by making R1 variable, as shown in Fig. 1. As the wiper arm on R1 moves from right to left, the feedback voltage around the operational amplifier decreases and the effective Q of the bridged-T network is reduced. Thus, if desired, R1 can be made variable and functions as a "Q" control. Otherwise, R1 can be a fixed value resistor and R2 is connected to the junction of R1 and R4 to produce a single frequency, deep notch audio filter. In this case, the only variable control would be the dual 50K ohm potentiometers which vary the time constant of the bridged-T network and hence the notch frequency. The dual potentiometer is capable of varying the notch frequency over about a 10:1 frequency range – 300 to 3,000 cycles approximately. This range should certainly suffice for most applications but, if desired, the range can be changed by using different (but equal) values of capacitance for C1 and C2.

The differential operational amplifier used may seem an unusual component to

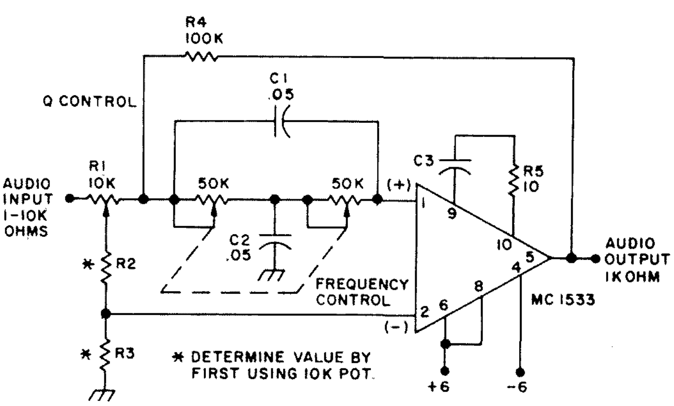

Fig. 1. Schematic diagram of the variable frequency and variable bridge-T notch filter. Various other IC units may be used besides the unit shown.

many readers. Although the basics of integrated circuits cannot be explored in this article, it should be realized that the integrated circuit used is only a multi-stage transistor amplifier packaged into a housing the size of the usual single transistor. The main feature that separates the differential amplifier from a conventional amplifier is its input circuitry. The "differential" input has a non-inverting (+) and inverting (-) input. A positive-going voltage applied to the non-inverting input produces a positive-going output voltage. The same voltage applied to

the inverting output produces a negative-going output. Thus, the same value and polarity voltage applied to both inputs will produce no output.

Fig. 1 shows the use of a Motorola MC1533 operational amplifier, but almost any similar unit will suffice. A number of inexpensive "surplus" IC operational amplifiers are available from such suppliers as Poly Paks, Lynnfield, Massachusetts 01940. Other units may differ in their voltage requirements and roll-off compensation needs (the RC network between pins 9 and 10 on the MC1533), but this information is usually supplied with the unit. It should be noted that a simple integrated circuit audio amplifier cannot be used; such units do not have differential input circuits.

Construction

There are very few precautions to be observed in constructing the unit because of the nature of its operation. One possible method of construction which the author explored is shown in Fig. 2. All of the circuit components are mounted on a piece of vectorboard which in turn is mounted on the rear potentiometer of the dual 50K ohm potentiometer. A piece of foam plastic material is glued between the underside of the vectorboard and the rear potentiometer to achieve the mounting.

The parts layout shown for the vectorboard in Fig. 2 need not be followed exactly, although it was the simplest which the author could devise. If an integrated circuit packaged in a dual-inline container is used (rectangular with 5-7 connections on each long side), the IC can be mounted on the left side of the vectorboard and R5 and C3 both placed under C1. No "Q" control is provided for in the parts layout shown, and R1 is a fixed value resistor. R1 need only be made variable, as shown in Fig. 1, if this feature is desired. The values of R2 and R3 can only be properly chosen by first using a 10K ohm potentiometer in their place (with the wiper arm going to terminal 2 on the IC) due to component value variation. The procedure is fairly simple. The wiper arm on R1 (if a variable unit is used) is first set towards the junction of R1 and R4. Then, using an input signal containing a frequency which the notch filter can reject, the dual 50K ohm potentiometer is adjusted for maximum rejection. Leaving this control set, the temporary potentiometer used in place of R2 and R3 is adjusted for complete signal rejection. At this point, the arms of the 10K ohm potentiometer are measured and replaced by equivalent value fixed resistors.

The resistors used in the notch filter can either be ¼ of ½ watt sizes. The capacitors need be rated no higher than the maximum value of the supply voltage used for a particular IC. The capacitors used in the bridged-T network should be of good quality to achieve the sharpest notch selectivity. Disc ceramic types are acceptable, although, if possible, low-loss types such as the Aerovox P123ZN series are preferred. The current demand from the power supply is in

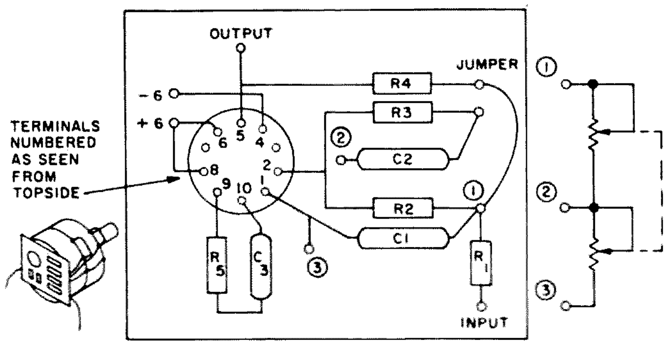

Fig. 2. No particular circuit layout is necessary but the components can so compactly be grouped on vectorboard that the entire circuit mounts on the back of the frequency control potentiometer.

the order of a few milliamperes, but the operating voltages should be obtained from a well-filtered source to avoid any possible hum problems.

The dual 50K ohm potentiometer used in the bridged-T circuit is a standard linear taper type. Although one can purchase such potentiometers from various supply houses, particular attention should be paid to being "cost-conscious" about this item. The author has found such potentiometers available for as low as 35¢ as compared to prices of $3 for similar units at regular catalog prices.

Mounting and Operation

The mounting or placement of the notch filter in a receiver or transceiver is fairly flexible. The unit can be inserted between almost any two audio stages. DC blocking capacitors must, of course, be used to prevent other than audio frequencies passing through the filter. Alternatively, the unit can be used completely external to a receiver or transceiver. The audio output from the receiver or transceiver can be taken from a headphone jack or from the loudspeaker terminals through a transformer (4-10 ohms to 1K ohm or more). The gain of the

operational amplifier, in the latter installation, is more than sufficient to drive any pair of medium to high-impedance headphones.

Operation of the notch filter is extremely simple. When not in use, the filter is adjusted for maximum low-frequency attenuation. As qrm develops, the filter is used (in conjunction with tuning of the receiver bandpass) to eliminate the most severe interfering beat (on SSB or CW). The result is an almost complete attenuation of the interfering signal while still retaining the full fidelity of the desired signal. The difference between this method of qrm elimination and that which depends upon a severe reduction in bandpass to accomodate only the desired signal is quite startling in terms of fidelity and ease of tuning.

Summary

Many thanks are due to Herman Gelback, W7JPU, of the Boeing Company, who completely developed the original circuitry of the IC notch filter and who allowed the author to present this description of its operation. Herman has also suggested that besides the MC1533 IC, another suitable off-the-shelf IC would be the General Electric PA-230, which sells for just over $3.

. . . W2EEY/1

PC Board Improvement

Before starting to wire your next printed circuit board, kit, or homebrew, take time to save yourself trouble later. Drill out all holes where wires connect to the proper size and install Vector terminals. This eliminates future problems involved in trying to reconnect wires to holes which are out of sight beneath a pool of solder. The possibility of lifting the foil during repairs is also minimized.

Another place where this technique bears fruit is in a situation where a component must be removed in order to make circuit adjustments. Some transceiver front ends are a prime example. In order to neutralize the RF stage it is necessary to remove plate voltage. This is done by removing a resistor from the pc board at a point which is at best impossible to reach. Reinstallation is even worse, calling for at least three hands, long nose pliers, and a truck driver vocabulary. After the Vector terminals are installed on the *bottom* of the board, removal and installation is a distinct pleasure. SB-110A owners please note.

William P. Turner, WAØABI

Converting the AN/VRC-19 Transceiver

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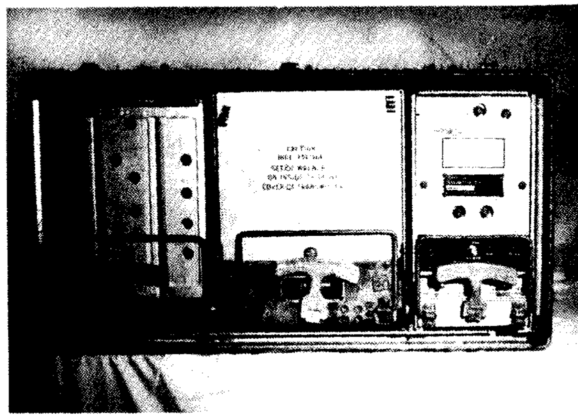
Garden Grove, California 92641

Recently there has appeared on the surplus market, and through MARS channels large quantities of a unique vhf FM transceiver called the AN/VRC-19. The three versions of this set all cover the same frequency range (152-174 mhz), but they differ in their input power requirements. The most commonly encountered version is the AN/VRC-19 X which is the 12 volt model. The set consists of a single case containing a transmitter (T-278/U), receiver (R-394) and a dynamoter power supply. It was originally designed for use in military police vehicles and other non tactical applications. It is of 1950 vintage having numerous sub miniature tubes. Typically, the sets are found without the control head or manual.

Basically, the set is a wide band (15 khz deviation) single channel crystal controlled transceiver with a 30 watt output. The transmitter has provision for operation on two channels providing that they don't differ by more than 500 khz. However, this feature was seldom used and most of the transmitters will be found with the channel 2 1AD4 oscillator tube missing. Also, don't worry if you see a hole for a missing module in the receiver. This is for the re-transmission relay which is normally not supplied.

Getting the set on the air consists of solving two problems- wiring in the controls, and obtaining power. This article will assume that you will use the set mobile from a 12 volt battery.

The fastest way to get on the air is to get a C-847/U control head and apply 12 vdc (at 24 amps on transmit) to terminals 1 and 2 of J-806. The control head has two terminal boards inside. TB-1501 and TB-1502. The terminals on these boards are numbered 1



The AN/VRC-19 with the front cover removed. The receiver is the unit on the left.

through 20. Connect these to terminals 1 through 20 of TB-804 and TB-805 in the case (see **Fig. 1**). The C-847 head is rare, so the circuit shown in **Fig. 2** was built to replace it. The controls including a 3" speaker were mounted on a 5¼ EIA panel.

After assembling and wiring the control panel, you will have to obtain the proper crystals. These should be CR-27's for the transmitter, calibrated for a 32 pf circuit. The receiver uses CR-32 third overtone crystals. The transmitter crystal frequency is obtained by dividing the desired output frequency by 32. The receiver crystal frequency is calculated by:
Crystal freq.=desired frequency(mhz)-7.8/6. The receiver crystal oven assembly is located in the local oscillator module.

Receiver alignment

After installing the receiver crystal in the oven, turn the power on and allow the receiver to warm up for 15 minutes. Connect vtvm between the LO and GND test points. Adjust the four slugs on the local oscillator module (Z-31, Z-32, Z-33, and Z-34) for maximum negative voltage.

Next, move the vtvm probe to the 2nd *if* test point. Connect a signal generator to the antenna connector and tune it to the desired operating frequency. Adjust the five slugs on the *rf* amplifier module for maximum negative reading on the vtvm while keeping the

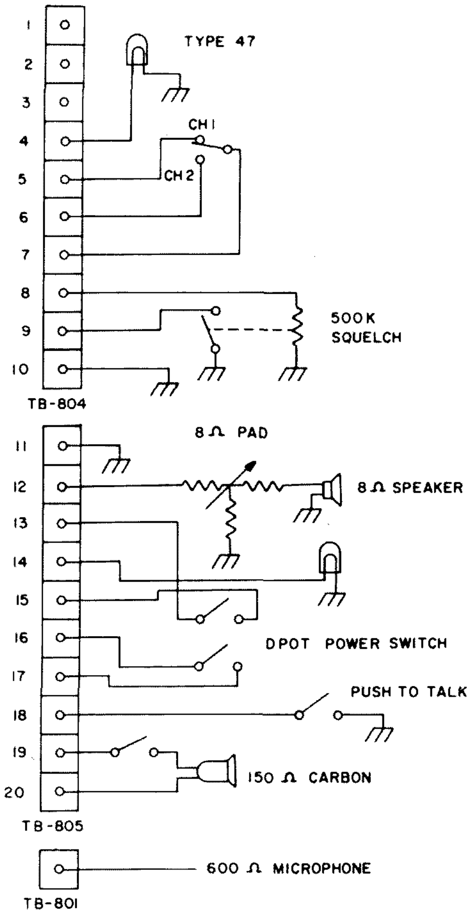


Fig. 1. Control Schematic For AN/VRC-19 Transceiver.

signal generator output as low as possible.

Precise adjustment of the receiver frequency can be obtained, after the above alignment, by connecting the vtvm between DISC and GND test points and adjusting Z-31 (top slug in the local oscillator module) for zero reading on the vtvm when receiving the desired frequency.

Transmitter tune up

First get your hands on cable assembly CX-2371, or build a jumper cable 30" long so that you can work on the transmitter out of the case. Without this it is impossible to align the transmitter.

Remove the dust covers from the transmitter and turn the set on, allowing it to warm up for at least 15 minutes. Set the channel selector switch to channel 1. Turn the coupling control to minimum and place the Tune/Operate switch in the tune position. Set capacitors C-403 and C-404 to their mid point positions. The test/off switch is used to control the transmitter during the alignment procedure. Do not operate the transmitter for more than a few minutes at a time or the dy-

namotor will overheat.

Place the vtvm probe in J-401 and adjust Z-401 for maximum deflection. Then back it off until it is reduced to 2/3 of its maximum value. The reading should be approximately - 3.5 volts. Next, place the probe in J-402, 403 and 404, adjusting Z-402, Z-403 and Z-404 sequencially for maximum deflection. Place the probe in J-405. Set Z-405 to approximately the same physical setting as Z-404. Adjust C-429 for a maximum reading, then peak using Z-405. Repeat as these controls interact. Replace the dust covers and reinstall the transmitter in the cabinet.

Place the vtvm probe in the driver grid jack and adjust the final grid tuning capacitors C-437 and C-439, and the driver plate tuning capacitor C-436 for maximum.

Set the tune operate switch to the operate position. Place the vtvm across the PL CUR jacks and connect the antenna or dummy load. 2.5 volts is equivalent to 100 ma. Dip the final tank using the plate tuning control, and adjust the antenna tuning capacitor for

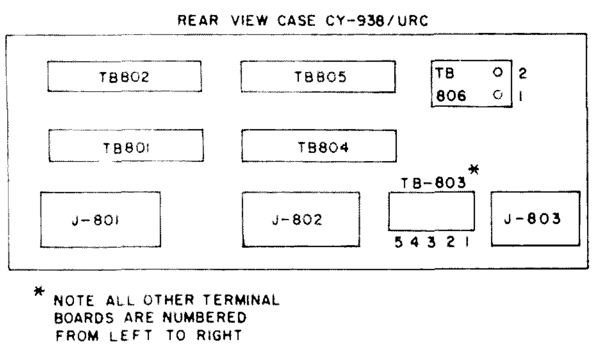


Fig. 2. Terminal Board Locations.

maximum plate current. Increase the antenna coupling while repeating the adjustments of the plate tuning and antenna tuning controls until the plate current reaches 140 ma. Connect the vtvm across the BAL test points. The reading should be 0. If there is a deflection, adjust the final grid controls until a zero reading is obtained.

Precise adjustment of transmitter frequency can be accomplished using C-403 for channel 1 and C-404 for channel 2.

The set is now ready for operation. This set has a unique re-transmission feature enabling it to operate as a repeater. This requires installation of relay assembly K-271, to be plugged into the empty cell in the receiver, and terminals 1 and 10 and 2 and 9 of TB-801 to be jumpered. If you use the set in this mode be sure the squelch is operating, or the transmitter will transmit constantly.

As a matter of interest, the receiver can be used on 60 hz, without modification, simply by unplugging the vibrator and fuse and applying 6.3 vac 4 amps to terminals 4 and 5 of PP-867/U. The transformer is designed for 95 hz operation and the 6.3 V winding is rated at only 1 amp, but it is husky enough.

There is a 110 V power supply available for this set. The receiver uses a PP-846/U and the dynamotor assembly is replaced by a PP-804/U supply. If these supplies are available, it is simply a matter of applying 115 V 60 hz to terminals 4 and 5 of TB-803.

The unit on hand was tuned to operate on 148.01 mhz without any circuit changes. Judging by the settings on the controls, it should be possible to cover the upper portion of 2 meters without padding. Additional information can be found in TM-11-297, the technical manual for the set.

...W6JTT

Rhyme with Reason

"Thirty days hath September, April, June and November..." What would we do without this handy little rhyme to tell us the number of days in the months?

Why wouldn't a rollicking rhyme help us to memorize the many confusing terms and definitions we meet in beginning radio? Does a volt or amp light up the lamp? Watt keeps hot the coffee pot?

In assisting some 75 Novices over the last fifteen years, I discovered these terms or "tools of the trade" to be the hardest thing the student had to learn—and to tell one from the other! And the student must know them well before he can even begin to discuss the fascinating topic of ham radio.

Nobody would think of starting to assemble a transmitter or vacuum tube voltmeter without being able to recognize a screw driver, pliers and soldering iron—plus the ability to use them.

Let's see what we can do with the subject in rhyme right now!

An ampere is a rate of flow
Like gallons in a minute,
A coulomb is how much the pail
Eventually has in it.

A volt, like water pressure
Expressed in PSI (Pounds per square inch)
Is pushing force and is of course
What sends the amperes by.

The ohm, resistance, tries to stop
The ampere as it flows,
Remember how the water slows
In long, long lengths of garden hose?

A kilo is a thousand of, (1000)
Let's learn it right away,
So when you see the FCC
You'll grin and bless the day.

MEG means a million of, (1,000,000)
As everybody knows,
Try writing down the figure 1
And follow with six o's.

A micro means a millionth of, (.000 001)
Be sure you get the point,
Pico one millionth micro,
Both eyes jump out of joint.

For frequency it's cycles, (per sec)
Or hertz these modern times,
It doesn't make much difference
For neither one will rhyme. (Kilocycle now Kilohertz) (Megacycle now Megahertz)

Inductance comes by henrys,
It's like a stretching spring, (Current lags in coils)
Delays the current for a while
But gives back everything. (No power loss)

Capacitance is farad,
It's like that spring let go,
CAPS store up "juice" then turn it loose
To leap ahead and flow. (Current leads voltage wave)

The watt is rate of power used,
Volts multiplied by amps,
It's on appliance name-plates,
Like toasters, irons and lamps.

The joule is simply energy,
One watt per second's time,
Hold on, have patience, this is all,
We'll quickly end this rhyme.

KW meters multiply
Volts push X amps X hours,
And you must pay each thirty days
For energy from power.

Now get to work and memorize
This swinging little rhyme
And you will "best" that Novice test
In half the usual time!

D.A. Hoover, W9VEY

Jim Kyle, K5JKX

The Greatest DX of All!

Old-timers like to tell of the "good old days" when they proved the worth of those useless short waves below 200 meters- -and a newer generation of pioneers can rightfully claim their honors for the first low-power earth-moon-earth contacts on uhf.

It's true, too, that the first working parametric amplifier was built by a ham in his home shop. Even Hertz and Marconi were "amateurs" in the strictest sense of the word, at first anyway, so amateur radio can truthfully claim to have pioneered the art of radio communications.

Unfortunately, as the state of the art has expanded in ever-widening spheres, the cost of experimentation and the depth of knowledge required in order to be aware of just where today's frontiers may be located has made it exceedingly difficult for hams, 1968 model, to maintain the pioneering tradition.

If this bothers you, cheer up! There's at least one major frontier still left open to ham exploration, and it won't cost you the price of a new rig to enter it. Any results you come up with may be as far-reaching in their effects as were those of the earlier generations, and the study may (if you happen to have that turn of mind) be even more interesting than were their efforts.

Interested? Read on.

This one remaining new frontier was first broached in the winter of 1931-32, with publication of an article in the Proceedings of the I.R.E. titled "Atmospherics at High Frequencies." VHF addicts may be interested to know that the original article is followed, in bound copies of the proceedings, by another pioneering study titled "The Ionizing Effect of Meteors in Relation to Radio Propagation"- -but that's outside our subject right now.

The paper on atmospherics reported upon tests made on behalf of RCA at Holmdel, New Jersey, by an engineer named Karl Jansky. RCA's communications network, like all others then and now, had been plagued by atmospheric interference, and Jansky had been assigned to use a sensitive receiver and directional antenna to attempt to locate the sources of this interference.

He located three types of interference and charted all three over a period of several months. One of the three types gave birth to a new branch of science.

In his original report, on page 1930 of the 1932 volume of Proceedings of the I.R.E., Jansky described it: "The static of the third group is also very weak. It is, however, very steady, causing a hiss in the phones that can hardly be distinguished from the hiss caused by set noise. It is readily distinguished from ordinary static and probably does not originate in thunderstorm areas."

Jansky's report went on to describe the arrival direction of the signal and its changing relation to the sun's position in the sky. As the sun's rays became more and more perpendicular at the receiving station, the signal source appeared to move more and more toward the west.

"It would appear," wrote Jansky, "that the change in the latitude of the sun is connected with the changing position of the curves. However, the data as yet only covers observations taken over a few months and more observations are necessary before any

hard and fast deductions can be drawn."

In this first report, Jansky speculated that the static might come either "directly from the sun, or, more likely, it may come from the subsolar point on the earth."

A second report several months later corrected this conclusion. As the spring of 1932 advances, the source of the unknown signal failed to keep step with the sun's position. It became increasingly evident that the source of this signal was not on earth, or even in the solar system, but somewhere farther out.

Surprisingly enough, the discovery made little stir at the time in scientific circles, although newspapers and network radio made much of the signals from outer space. When Jansky completed his original assignment, his discovery was almost forgotten.

With one exception. A young ham in Wheaton, Illinois, just out of college, found his imagination fired by Jansky's discovery. At the age of 22, Grote Reber, W9GFZ, became the first ham radio astronomer—and for a dozen years, until 1945, he was the only radio astronomer in the world!

By the time Reber was ready to start collecting his gear, several years had passed. The time was late 1936. Considering the state of the radio art at that time, his plans appear almost impossible—yet he designed and built a 31-foot parabolic reflecting antenna, almost entirely from wood except for the galvanized-iron reflector surface itself.

"All the wooden pieces, including the lattice parapet, were cut, drilled, and painted by me personally," Reber wrote in an article prepared for the special Radio Astronomy issue of the I.R.E. Proceedings published in January, 1958. "Part time assistance. . .was secured on the foundations, metal parts, and erecting the structure, with the exception of the skin which I personally put together piece by piece."

Erection of the antenna took him four months, from June to September of 1937. The antenna is still in existence; in 1947 when Reber joined the National Bureau of Standards it was disassembled and re-installed on a turntable near Sterling, Virginia. Some 5 years later it was disassembled and the parts sent to Boulder, Colorado. Since then, it has been made available to the National Radio Astronomy Observatory for exhibition purposes.

Anyone who hopes to be a pioneer by ordering the latest equipment fresh out of a catalog should read Reber's own account; there's room here to cite only the highlights. When the two-ton antenna was completed, the work had barely begun. Some type of receiver, also, was necessary- -and in the mid-30's, uhf had hardly been explored at all. All Reber's first attempts at reception were on a frequency near 3300 mc.

The entire spring and summer of 1938 was spent working at 3300 mc with a variety of receivers, but no repeatable results were obtainable. ' All this was rather dampening to the enthusiasm," Reber reported.

Reluctantly, he decided to come lower in frequency. A new receiver for 910 mc was built, using type 953 and 955 acorn tubes. The cavity resonator for this receiver was a steel drum which originally held 100 pounds of white lead, and the dimensions of this drum determined the exact operating frequency.

The autumn of 1938 and the following winter were spent in a duplication of the earlier year's work, but at lower frequency. Again, W9GFZ found no positive results. "In a measure, it was disappointing," was his reflection 20 years later. "However, since I am a rather stubborn Dutchman, this had the effect of whetting my appetite for more."

"It was perfectly clear," he continued, "that a further great increase in sensitivity

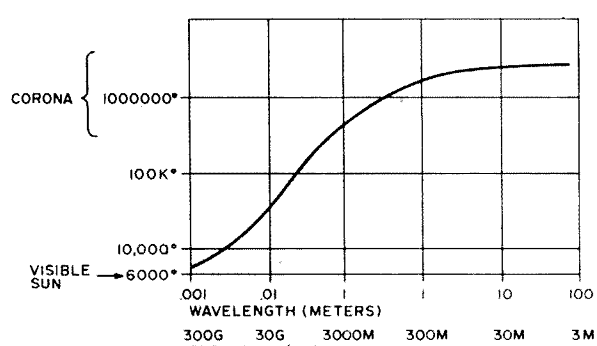


Fig. 1. Comparison of sun's radio-frequency output across hf, vhf, uhf, and ehf frequency spectra. Most hf energy comes from high-energy corona while visible light and heat come from cooler photosphere. Radio astronomers tend to talk in terms of wavelength rather than frequency, thus both are shown here.

was necessary." The only answer to that was to come still lower in frequency. A frequency near 150 mc was selected and a state-of-the-art receiver using type 954 tubes and coaxial line resonators was constructed. It was completed in the early spring of 1939, and on the first Saturday when help could be obtained, was installed at the focal point of the huge dish in the Reber yard.

This time it worked. In early April 1939, good reproducible plots were being secured every night that observations were made. At this stage, the plots were made manually recording signal strength once every minute- -a practice which limited the observations to those hours which Reber could spare from his fulltime employment in the Chicago radio-manufacturing industry.

The only signals which could be located with this setup were those from the Milky Way. In addition, the signals were much weaker than any then-existing theory predicted. Equipment difficulties continued, since the entire project was a one-ham operation with no subsidies from any outside source. Nevertheless, Reber published his first reports in the February, 1940, issue of I.R.E. Proceedings and the June, 1940, Astrophysical Journal.

The success, limited through it was, whetted Reber's appetite, and he immediately turned his efforts toward the making of a complete radio survey of the sky.

With this in mind, he purchased automatic recording equipment early in 1940, and constructed an array of test equipment with which to keep the receiver properly maintained. The survey, at a frequency of 150 mc, was begun in 1941 and results were published in August, 1942.

A world at war had little time for such far-out pursuits as radio reception from space, but Reber stuck with it. Better vhf tubes became available and a completely new wideband receiver was designed and installed. A re-survey was begun in 1943 and published in late 1944.

"When it became apparent, toward the end of 1943, that the situation was fairly well in hand at 160 mc," Reber's recollections continue, "I cast about to see what could be done at higher frequencies to improve the resolution." He obtained some 446B lighthouse tubes in the summer of 1945, and built a 6-stage 480-mc receiver. Observations at the higher frequency began in the summer of 1946, and this series was the last work done from the urban Wheaton location. The following year, Reber joined the NBS as a radio physicist. This final series accomplished two major points: it provided the expected increase of detail in the sky map, and it revealed a completely unexpected phenomenon in the sun's production of radio signals. Both were highly significant.

Meanwhile, in 1942, J.S. Hey in England and G.C. Southworth in New Jersey independently recognized radio signals from the sun during the course of radar experiments. Their reports were delayed for military reasons and Reber's 1944 report was the first published.

When the war came to an end, many scientists in England, Australia, and Europe followed in Reber's pioneering footsteps. Hey himself, is credited with three major discoveries, which is a significant percentage of all the major discoveries so far in this field. The list of those in the field is much too long for this space; progress was paced by Hey, a group in Sydney, Australia, under J.L. Pawset, and another group in Cambridge, England, led by M. Ryle.

By this time, the major emphasis was on high-resolution sky surveys with huge antennas. John Kraus, W8JK, at Ohio State University, made major contributions with a 96-element array of helix antennas operating near 300 mc, and a double reflector array 360 feet long by 70 feet high. The first half of this second array cost $48,000 to build. Installations of this nature, obviously, are out of reach for the individual ham.

Other such installations include several "Mills Cross" antennas in Australia, the 260-foot Jodrell Bank radiotelescope in England, and of course the 1000-foot Arecibo dish scooped out of a mountain in Puerto Rico (which is occasionally used for ham work)!

An Alternate Approach

The year 1958 was designated as the International Geophysical Year, and scientists all over the globe banded together to obtain and exchange data. That year was picked be-

cause it was expected to be a sunspot maximum- -and the choice was fortuitous indeed, because 1958 set all-time record for solar activity. Many operators made WAC on 50 mc with the aid of sunspot-induced abnormal F2 skip frequencies.

While the major emphasis of radio astronomers from 1945 onward has been upon deep-space exploration- -the latest significant discovery in this direction is that of the quasars, which may be the most distant objects ever detected- -solar physicists have continued to show high interest in the questions raised by Reber's discovery of "impulse noise" from the sun, and some discrepancies between theory's predictions and the observations of Hey and Southworth.

As any photographer who works with color film knows, the "color temperature" of sunlight is about 5900 degrees Kelvin. That means that the sun radiates light of the same nature as would be expected from a theoretical "black body" heated to 5900 degrees above absolute zero- -and that's the temperature which had been accepted as the reading for the sun's surface.

The interior of the sun is thought to be much hotter, in the tens of millions of degrees, but the surface (as measured by its color) must be about 5900 degrees K. Southworth's observations of the sun's radio signals agreed with this temperature; he reported 6000 degrees K as the temperature of his signal source.

But a little later the result was corrected to 18,000 degrees, much hotter. Spectroscopic analysis of light from the sun's corona indicated a temperature there, far above the surface, of about one million degrees- -and the radio signals failed to match this.

At the time it occasioned little surprise, since the high temperature of the corona was not widely accepted. But evidence in favor of the million-degrees temperature continued to accumulate.

It was finally discovered that the corona acts as a sort of "leaky shield" for the solar mass beneath it. At high frequencies, the super-hot corona puts out little radio energy while the cooler "photosphere" (the visible portion) produces all the energy which we detect. As the frequency goes down, the photosphere's output drops while the corona's output climbs–and so does the apparent temperature. **Fig. 1** is a graph showing this effect.

And this effect–the usefulness of low-frequency signals in study of the sun- -is the pioneering field still open to today's hams who want to break new ground.

Not all the signals from the sun, of course, are at low frequencies. As shown in **Fig. 1**, they span the entire spectrum of electromagnetic radiation- -including, of course, infrared (heat) and visible light!

Most of the direct-reception methods for high frequencies, however, require precise antenna tracking over small areas of the solar disc. This puts them out of the "reasonable" realm for individual ham effort because of the size of antenna farm required.

The one exceptionally promising area open to the would-be ham pioneer is an indirect method of detecting solar flares by means of "sudden enhancement of atmospherics" (SEA) and "sudden enhancement of signals" (SES).

For more than a decade such studies have been conducted by the American Association of Variable Star Observers, Solar Division. The AAVSO is one of the few amateur (not ham- -rather "non-professional") organizations fully recognized by scientific authorities, and their reports are included in official publications of the Environmental Science Services Administration.

Despite its recognition, the group is relatively small. It has fewer than 100 members. Spark-plug of the project is David

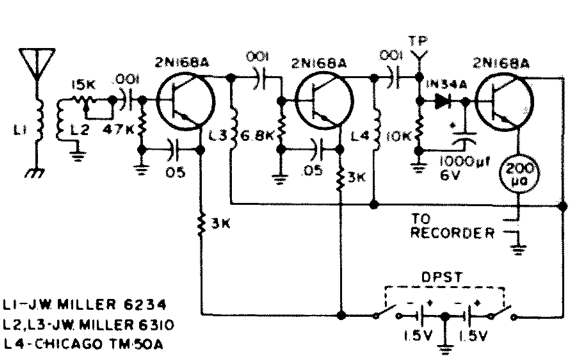


Fig. 2. Schematic diagram of Warshaw solar-flare indicating receiver. Coil L1 is adjustable from 60-130 millihenries while all others are fixed 50-mh units. L4 is a toroid for reduced magnetic field and higher output. Gain is controlled by 15K pot in input circuit; test point is for oscilloscope monitoring if desired. Circuit is relatively straightforward and not particularly critical.

Warshaw, a technical supervisor with ITT World Communications, Inc., whose address is 544 State Street, Brooklyn, N.Y., 11217. If you're interested, he can provide details on how to join.

The major effort carried on by the AAVSO group is a continual recording of SEA and SES effects, as a part of the international Solar Flare Patrol efforts originated during the IGY in 1958. They use, for the most part, a simple transistorized receiver operation at about 27 kc which was designed by Warshaw.

The receiver is merely two stages of tuned rf amplification followed by a detector and a dc amplifier which drives an indicating meter. Most of the observers use an automatic chart-drive recording meter, which is far and away the most costly part of the installation. **Fig. 2** shows the schematic of one version of the receiver; several versions are in use.

The VLF method of solar flare detection depends upon the effects of solar disturbances upon the earth's own ionosphere. These effects are believed to be due to x-rays emitted by the flare, which reach the earth at the same time as light. Auroras and magnetic storms, also affected by flare activity, are affected by particle streams which take several hours to reach the earth after the flare. The VLF detection method thus offers some warning of possible magnetic storms.

In the absence of a flare, the ionosphere on the sunlit side of our planet contains the D layer, from 30 to 54 miles above the surface of the earth, which absorbs most low-frequency energy. This is why 80 meters is a short-range band during daylight.

When a flare occurs, the x-rays produce an extra layer of ionization which extends down to about 12 miles below the D layer, and which reflects radio energy instead of absorbing it.

At night, the D layer disappears and the remaining E and F layers reflect. No flares can be detected under these circumstances. **Fig. 3** shows the day-to-night variation of signal levels observed in the 27-khz region.

Source of these signals, incidentally, is thunderstorms in the tropics. Enough such storms are in progress at all times to provide a steady source of random vlf energy.

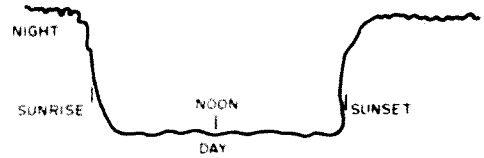


Fig. 3. Day-to-night variation of vlf energy is shown here. During night, signal levels are high with much fluctuation. In day, signal level is very low by comparison. Only the daytime levels are of use for astronomical purposes. Curved appearance of these and following traces is due to type of recorder from which originals were taken. Recordings have been reversed to maintain conventional left-to-right time flow as well; the recorder produces right-to-left tracings with the most recent events at the left.

These are the "atmospherics" of the SEA observations. For SES observations, the receiver is tuned to a vlf transmitter such as NSS, and the changes of its signal level are noted.

Observations of both SEA and SES effects require little effort if an automatic recorder is used. As in all types of radio reception, interference may prove to be a problem. The trace left by an SEA or SES is, however, very different in its appearance from that produced by interference, as shown in **Fig. 4** which illustrates several types of SEA's together with interference.

One discovery has already been attributed to the AAVSO observations--that of a ring of ionization circling the earth at the twilight-sunset junction. This was first observed by Harry L. Bondy, chairman of the AAVSO Solar Division, as a slight dip in the traces 35 minutes before sunrise followed by a hump about 15 minutes later. Bondy's observations were made in 1958. They have been confirmed by all observers in the following years, but as recently as 1965 the University of Natal, Durban, South Africa, reported that "no satisfactory explanation of this phenomenon has been possible." Warshaw on the other hand believes that it is a ring of ionization due to solar energy passing through the upper layers of the atmosphere and illuminating the D region from beneath, causing another and more intense region at the division between the sunlit portion and the earth's shadow. **Fig. 5** shows typical tracings of this effect.

Practical Receiver Details.

Although as mentioned earlier a number

of vlf receivers have been used by the AAVSO group, that shown schematically in **Fig. 2** is the one most widely used and time-tested. The design dates from 1958, so some of the parts may have been superceded by more recent ones and the transistors specified in the schematic may not be on hand in all parts stores. These should be only minor problems for a true pioneer.

Coils L1 and L2 which form the input circuit for the receiver are pre-wound J.W. Miller items. L1 is an adjustable 60-130 millihenry unit, while L2 is a 50-millihenry rf choke (as is L3). The slug of L1 should be opened two turns from the fully-in position to tune to 27 khz, while L1 and L2 should be mounted about 1/2 inch apart for proper coupling.

Inductance of L4 is also 50 millihenries, but a toroidal inductor is used here to provide best output and reduce stray magnetic coupling which could lead to instability problems. Tuning capacitance for the various tank circuits is provided by the 0.001-mfd series capacitors, so that the base-emitter junctions of the transistors are in series in the tank circuit rather than shunting it as is more often the case.

Lack of base bias may alarm some; the 3K emitter resistors make the emitters more negative than ground, and since the bases return directly to ground through R2 and R4 they are actually forward biased. C2 and C4 provide bypassing of the emitter resistors for desired rf. The final stage is used only as a dc amplifier, while the scope test jack is a handy convenience during tuneup and adjustment. The 0-200 microameter shown is also primarily a convenience, since it is in series with the recorder.

Recommended recorder for use with this receiver is the Rustrak miniature chart recorder which comes in 0-50, 0-100, and 0-200 microamp sensitivity ratings as well as in more rugged sizes. The 0-100 microamp unit is the one most observers use; gain can always be cut down to stay within this range.

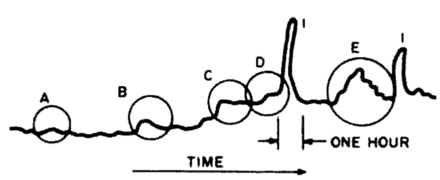


Fig. 4. Differences between traces of SEA's and interference are shown here. Circled records at A through E are SEA's of varying types ranging from almost undectable effect at A through violent symetrical peak at E. Interference traces are identified by I. Note that interference rises and falls much more rapidly than do SEA's; most SEA's last from 1 to 3 hours from start to finish.

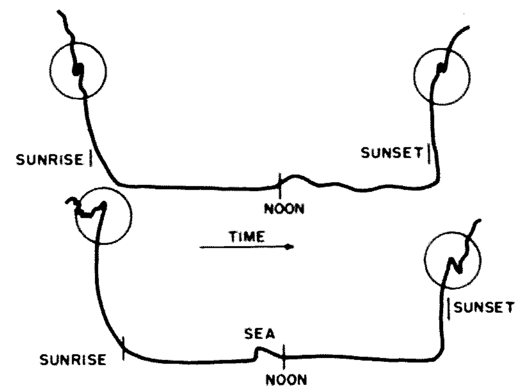


Fig. 5. These two tracings, dating from 1959, illustrate the twice-daily hump-and-dip effect which has not yet been fully explained. It has been observed by all members of the AAVSO team but is not always present. When it occurs, the dip happens about 36 minutes before local sunrise and lasts for some 8 minutes, then signal begins to peak and reaches its highest level about 20 minutes before fading. Similar timing is present at the sunset phenomenen. Some correlation with weather patterns has been noticed; the effect fails to appear on extremely cloudy days.

The recorder is sold by Allied Radio, but is listed only in their industrial-electronics catalog. Cost of this unit is about $95, making it far and away the most costly part of the entire setup- -but it does permit continuous recording of up to 31 days of observations, 24 hours a day, without the need for any human intervention.

Cost of the rest of the receiver should not exceed $20 even if all items are purchased new; most junkboxes can furnish at least half the required parts and many can supply all, since almost any transistor will amplify at 27 khz.

It wouldn't be fair to omit mention of problems you are likely to encounter if you try this. One of the greatest is that of electrical interference. Sparking electrical appliances put out sharp gobs of energy in this region, and the receiver is broad enough in its tuning to also be subject to trouble from the 31.5-khz second harmonic of TV horizontal sweep circuits. Both these problems can usually be cured by moving the antenna, sometimes as little as 50 feet making the difference.

The antenna itself should normally be as long as possible, but no one expects to be able to put up a 27-khz rhombic in most locations. Fortunately it isn't especially critical.

Other Facets.

While vlf observations of SEA and SES effects is one area of radio astronomy in which activity is heartily welcomed, it is by no means the only possible area which might prove interesting.

Jansky's original observations were made at a wavelength of 14.6 meters- -or about 20.5 mhz, very close to the present 15-meter band. Much other observation in the ensuing years has been done in this same region.

The sun is not the only member of our planetary system which transmits radio energy. In 1955, B. Burke and K. L. Franklin unexpectedly discovered that the planet Jupiter was a strong, sporadic radio source at 22 mhz. The signals from Jupiter appear to peak in strength around the 15-meter band, and are extremely weak when the frequency gets up to 38 mhz. These signals are rather sporadic; in the first four years during which they were observed they were found up to 22 percent of the time at 18 mhz, down to as little as 1.5 percent of the time at the same frequency but a different period. They may be connected with the sunspot cycle in some unknown manner.

Radiation has also been detected from Saturn, but it is too weak to be picked up without the huge professional antenna systems. Again, it appears to peak around 15 meters.

W8JK at the Ohio State University radio observatory has reported reception of signals from Venus in the 11-meter region, but they were even weaker than the Saturn signals and other professionals were unable to locate them immediately.

Of all these signals, none is stronger than the general "galactic noise" static discovered by Jansky, and only those from Jupiter reach that intensity- -which is in the neighborhood of 1/10 micro-micro-microwatt per square meter per cycle-per-second bandwidth! That is, 1×10^{-19} watt/meter $^{-2}$/(cps)$^{-1}$.

The sun's signals, on the other hand, are some 10,000 times stronger than this, or one milli-micro-microwatt per square meter per cycle.

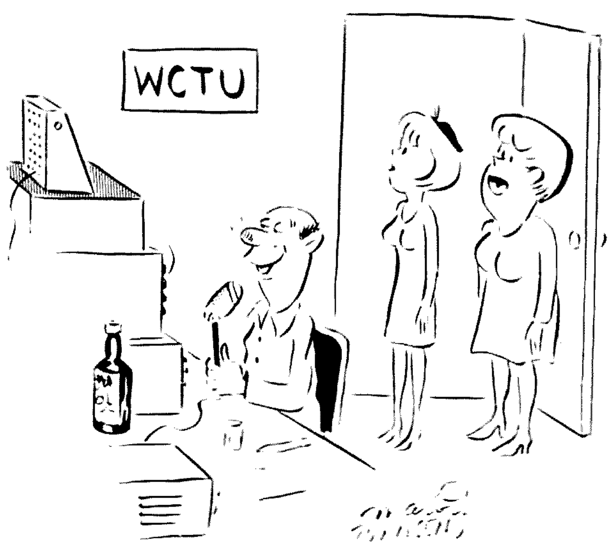
In both these sets of figures, the "square meters" refer to effective antenna aperture while the cycles per second refer to receiver bandwidth. For the sun's signals, this means that a receiver connected to an antenna one meter square with a bandwidth of 1 cps would receive one milli-micro-microwatt of energy (to an oversimplified approximation). Increasing bandwidth to 1000 cps would reduce the energy a thousandfold, while increasing antenna size to 100 square meters (10 by 10 yards, for example) would increase signal by a factor of 100. No matter how you slice it, these signals are pretty weak.

However, if you're tired of the DX rat-race or just looking for something new, you might give it a whirl. The DX available in this field is the most distant of all- -and Reber himself explained his initial interest in it as being because "after contacting over sixty countries and making WAC, there did not appear to by any more worlds to conquer."

. . .K5JKX

Errata

In VE3CEA's article on the Antennascope, May, 1969, issue, page 36, in the example quoted, change the 66' figure to 33'. Overall length was 66', not the legs. *(Do a better checking job, Ross - Ed).*



"Of all people to get those call letters!"

T. W. Banks, K3LNZ
426 Orange Street, S.E.
Washington, D.C. 20032

Intelligent Tube Substitution

Sooner or later, any ham finds himself in a situation where a vacant tube socket must be filled, and not with the same type tube. Examples would be (1) during a contest when Murphy's Law dictates that the only tube to burn out will be the one for which there is no spare, (2) a desire to "soup up" a piece of gear, or (3) it's so old it's hard to find a replacement. I have been all three routes, so present herewith my advice on selecting suitable substitutes.

Basic Principles

Probably the first consideration is that the replacement tube should fit the socket which awaits it. This is easy when one considers that standard codes have been provided for the various base connections. For example, reference to almost any tube manual will show that base 9A is used for the 12AT7, 12AU7, 12AX7, and quite a few others, all of which will prove to be twin triodes of varying amplification factors and other things. The next consideration is that one should stick to the same general class of tube such as "remote cutoff", "sharp cutoff", etc., otherwise there will be troubles with blocking, poor avc action, and so forth. Last is the knowledge that there is "nothing new under the sun". Example, a triode with a 2.5 volt heater known as a 56 evolved into a 6.3 volt type 76, thence (getting a little hotter) into the 6C5 octal-based variety, and still later into the 7-pin miniature 6C4. At the same time, "two in one" varieties 6SN7 and 12AU7 came along. Similarly, 6AU6, 6SK7, and most sections of modern multiple-section tubes can be traced back to familiar varieties of a few years ago. In other words, some browsing around comparing tube characteristics will supply you with a gold-mine of information for emergency use. All that follows are a few hints to aid in your search.

RF and IF amplifiers

Here is where the object is most often to get more gain and/or better noise figure out of an existing receiver. Explore carefully the range of cascode dual-triodes and *rf* amplifier pentodes (don't forget cutoff) and you'll find that the 6BQ7, 6BK7 and 6BZ7 are all one family – but nowadays a 6BS8, 6ES8 or 6DJ8 will be used, and justifiably so anywhere above 20 meters or so. Pentodes will run in families, but will almost always have one of two base connections, 7CM or 7BK. A look in the book will show these two are identical except for pins 2 and 7 to which the cathode and suppressor grids are connected. To make a switch from a 6AU6 to a 6CB6, which is a good (and useful) example, simply reverse the connections to pins 2 and 7. Yet a third family, 7BD, has both these pins tied together, so offers even more choices as long as the cathode and suppressor are (or can be) tied together. In any of the above cases, whether triodes or pentodes, the object would be to find a substitute with equal, or nearly equal, voltages on G1 (and G2, if a pentode) and equal, or higher, transconductance depending on whether you want equal or hotter performance. In the older tube types, 6SK7, 6SJ7, 6BA7 and 6AC7 all use the same base, and again offer varying degrees of "hotness".

Frequent Burn-outs

Now and then a tube is run too close to it's maximum ratings in a particular piece of gear and therefore quits with appalling regularity. Here is a situation where the book will often disclose a substitute which will do the same job, but not work so hard in the process. A good example (although you have to change sockets) is the 6BQ5 for an over-worked 6AQ5. Some direct replacements are the 12BH7 for the 12AU7 and the 6EA8 for a 6U8, the latter giving better re-

sults either as an oscillator/mixer or in Class C *rf* amplifier/multiplier service.

Rectifiers

The modern trend is to use solid-state diodes, which give more B+ due to lower voltage drop and don't require 10-20 watts of filament power. But what do you do when one goes west? The best way is to install sockets, provide the necessary filament voltage, then use one of the plug-in replacement units available. In a pinch, a tube may be pressed into service. If you build this way, or are already using tubes, you will find that the 5Y3, 5R4, 5T4, 5U4 and a host of less common varieties all use the 5T base. By wiring for this base, but then also tying pin 3 to 4, 5 to 6 and 7 to 2, even more types such as 5W4 and 5X4 can be used. Note that at any rectifier socket of the octal variety, the B+ should always be taken from pin 8, since that is where the cathode is connected on such types as the 5V4. At higher power levels, the 3B28 turns out to be a vacuum, and therefore less noisy, replacement for the mercury-vapor type 866. The replacement can therefore be made in the other direction when necessity demands something be done to stay on the air.

RF Power Amplifiers

There is frequently an urge to get some more signal out of an existing transmitter, usually at a lower power level, which is just as well since replacement of larger tubes usually involves complete rebuilding. If you have sufficient B+ available, a 6146 will replace a 2E26, or the newer type 6146B will handle still more power, and such a substitution will make a pretty big difference. On the other hand, you can go the opposite direction in an emergency, which certainly isn't any improvement, but beats going off the air entirely. The twin-tetrode family offers a fertile field for tube-swapping if you operate VHF, since the 6252 replaces the 832 and the 5894 replaces the 829 directly, and will operate much more efficiently to boot. There is also an in-between model, the 6524, which is bigger than the old 832 but smaller than the 829 or 5894. If you operate the lower bands, you might be interested in knowing that the old 815 is a pair of 2E26's in one bulb.

Making the Job Easy

The correct way to replace an obsolete, or otherwise un-wanted, tube is to install a new socket and re-wire for the substitute. I don't know how many conversion or modernization articles I have seen which say, "remove the old octal socket and mount the new 9-pin socket on a metal plate....." Don't you believe it! *Amphenol* makes nifty 7 and 9-pin miniature sockets that mount directly in the hole vacated by a ring-mounted octal, or even older, socket. However, there are times when you have to make a replacement in a hurry and/or don't care to dig into a bunch of old wiring. The solution in this case is an adaptor. Break the old tube and clean the glass out of the base, then heat the pins and shake out the old solder and wires. Make the necessary connections to whatever socket the new tube requires, bring the wires to the correct pins on the old base (using plenty of "spaghetti" sleeving where wires must cross) and plug the finished adaptor into the original socket, then the new tube into the adaptor. This is also a good way of trying out certain modifications, such as a cascode replacement for a pentode *rf* stage. If it doesn't work, or if you're afraid of lowering the re-sale value, just remove the adaptor and everything is the same as when you started.

Adding a Stage

There are many times when an additional tube would come in handy for a Q-multiplier, S-meter amplifier, bfo, more audio, noise-limiter, or a zillion other things. Here again, the solution is to dig around the tube characteristic charts until you find a near or exact replacement for one of the tubes presently in use, plus another section that will do the extra job you want done. A much-used trick is to substitute a 6S8 (octal) or 6T8 (miniature) for a 6SQ7, 6SR7, 6AT6, 6AV6, etc. diode detector and 1st audio. This gives you two more diodes for use as a noise limiter, avc, or what have you. An even better trick is to replace the diode detector with a 1N34 solid-state diode, then install a dual tube to replace the 1st audio stage and give you another tube for some additional function. The usual conversion information on the ARC-5 receivers tells you to rip out the bfo and convert it to an additional audio stage. Why not install a 1N34 for the diode that was in the original 12SR7, then rewire the socket for a 12SL7 and have your bfo and audio too?

In conclusion, there isn't a tube built yet that doesn't have an equivalent in another package, or a near-equivalent in the same package. Read the specifications, and you'll find that the sky's the limit on substitutions.

...K3LNZ

Build a Power Resistor Decade

For the homebrewer there are few gadgets which will save more time and get more use than a power resistor decade. While similar in nature to the more common precision decade is not required to be of close tolerance or to cover as wide a range of resistance. Ten or twenty percent tolerance is sufficient, and values of one ohm to 100K will cover 99% of your requirements. The power rating may be 5, 7, 10, or even 20 watts, depending on your needs and desires.

Each section of your decade need contain only 4 resistors, the values are 1, 2, 3, and 4 times the section multiplier. If you need seven ohms, open the switches across the 4 and 3 ohm resistors (or 4, 1, and 2).

In each succeeding section the values are increased by a factor of ten, for example, the hundreds section is made up of 100, 200, 300, and 400 ohm resistors. A total of twenty resistors are required along with 20 good quality switches. With this complement, it is possible to select any resistance from 0 to 111,110 ohms in one ohm steps.

By now you have calculated the cost of 20 resistors and switches. To be sure, they are not cheap, but by buying in this quantity it is possible to get good switches for about 20 cents each. The resistors are another problem, the normal catalog price being 35 to 40 cents each. By careful shopping in the bargain houses, it is possible to reduce this by at least 50% if not more. McGee Radio Co., 1901 McGee Street, Kansas City, Missouri, advertises a kit of 10 watt resistors in 100, 200, 300, 400, and 500 ohm values for only 59 cents. The same company also sells the same deal in values of 1K to 5K at the same price. These resistors alone will allow a decade covering 100 to 10K ohms in 100 ohm steps and would require only 8 switches.

The switches are wired in series with the resistors across the normally closed switch contacts. The desired value is selected by removing the short from the desired resistor by means of opening the switch.

The entire assembly is mounted in a chassis or other case, the size of which is dictated by the physical size of the components selected. Connections are made through your choice of terminals, binding posts, clips, or what have you.

In use, the leads from the decade are attached to the circuit under development and the switches adjusted for the desired result. It is best to start at the high resistance condition and work down in order to prevent damage due to over voltage or current. The value may then be read off the decade and a fixed resistor of the proper value installed.

You will also gain an extra advantage in that your resistor supply won't look as if they had been used over and over again.

William P. Turner, WAØABI

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Salem, Oregon

Passive Reflectors for Amateurs

Something for Nothing (Almost)

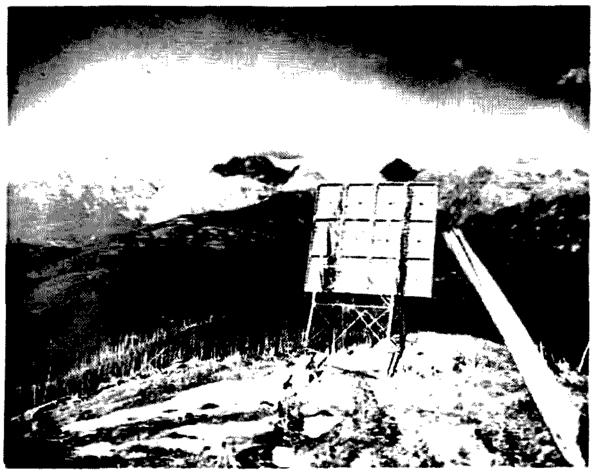
A state-of-the-art technique to increase your effective radiated power at microwave frequencies without receiver or transmitter circuit modification.

An often overlooked method in amateur circles, and even in the professional engineering society, of increasing the effective system gains at microwave frequencies is through the use of the antenna/reflector system. This system uses a parabolic antenna colocated with the transmitter-receiver and a remotely located plane faced reflector. **Fig. 1** diagramatically illustrates the arrangement.

Depending on various factors, such as operating frequency, antenna/reflector spacing, antenna diameter and reflector size, gains upward of 4 db to 5 db are easy to achieve in a practical arrangement. This is gain over and above the antenna gain available using just the parabola.

Before going into the techniques of calculating antenna/reflector combinations, there are some other advantages available through their use, that bear a little discussion.

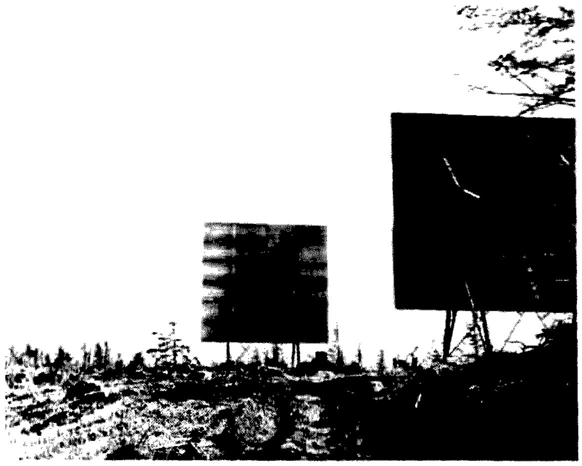
Suppose your microwave equipment is all peaked for performance. A hill, mountain or other high projection has been found that provides proper microwave path clearance* to a location with which you wish to communicate. However, power may not be available at the exact spot you want to use. And, perhaps an access road doesn't exist, so you can't get portable power up to the site. One solution would be to locate the microwave gear down low and run a long transmission line (usually high loss coax! What ham can afford an expensive and sensitive waveguide?) up the hill and mount the parabola at the top of the tower or on the roof of the building on the hill.



Commercial microwave systems, carrying as many as 960 simultaneous voice conversations or one video program or thousands of channels, use giant radio mirrors such as the one above. (Photo courtesy Microflect Co., Inc., Salem, Oregon.)

This very thing is often done in the common carrier, public safety, and industrial radio services except waveguide of one type or another is generally used. Even so, the ingenious microwave engineer often uses the reflector technique because it offers lower losses, and is generally less expensive. The reflector technique also allows the active equipment to be located at just about any point within a wide area. Of course, the reflector must be optimized for performance each time the active terminal is moved.

*Amateur Microwave Propagation, Ray D. Thrower, 73, November, 1966.



This double radio mirror redirects a microwave beam carrying 600 simultaneous telephone conversations from an active terminal 25 miles away to another active terminal 6.4 miles further on. It provides a 39.5 db fade margin in the 6 ghz common carrier band. (Photo courtesy Microflect Co., Inc., Salem, Oregon.)

One additional advantage that receives much consideration in the western states, where high mountains and deep winter snows are not compatible with mountain top microwave repeater stations, is the fact that the reflector may be placed up high while the active equipment may be placed at a low elevation where it enjoys year around accessibility. This way, one can enjoy the availability of amateur microwave propagation testing or communication on a year-round basis.

Transmission line is part of antenna system

The main drawback to direct mounting a parabolic antenna a long distance from the active equipment is the transmission line. The transmission line must be considered a part of the antenna system since the length of the line will affect the overall efficiency of the antenna. In Fig. 1, the overall length of the transmission line is 205 feet for the remotely located 10-foot parabola. The gain of the 10-foot parabola at 2.3 ghz is 34.5 db. However, commonly available 7/8" coaxial transmission line has a loss of 3.3 db per 100 feet. 205 feet of this line will have a loss of 6.8 db. This loss must be subtracted from the antenna gain (34.5 db) to obtain the antenna system gain which is 27.7 db.

Using the antenna-reflector

Converting the direct mounted parabola with its long transmission line to an antenna-reflector arrangement will provide a more efficient system as can readily be seen by looking at **Fig. 1**. It is necessary to use only a 6-foot parabola to achieve equal or greater gains than with the 10-foot parabola.

A 6-foot parabola has 29.9 db gain at 2.3 ghz. With only 20 feet of transmission line there will be only 0.7 db transmission line loss. Then, if a 10x15 reflector, elliptically shaped, is used and if the slant distance between the parabola and reflector is 121.7 feet, there will be 1.9 db Near Field coupling gain. So, adding all the gains and losses, we find an antenna system gain of 31.1 db which is 3.4 db greater than with the direct mounted 10-foot parabola. This is better than double the effective power and well worth the effort.

Calculations

The above comments and statements are just that. It now becomes necessary to provide curves and charts and the method of their use to prove the numbers just mentioned.

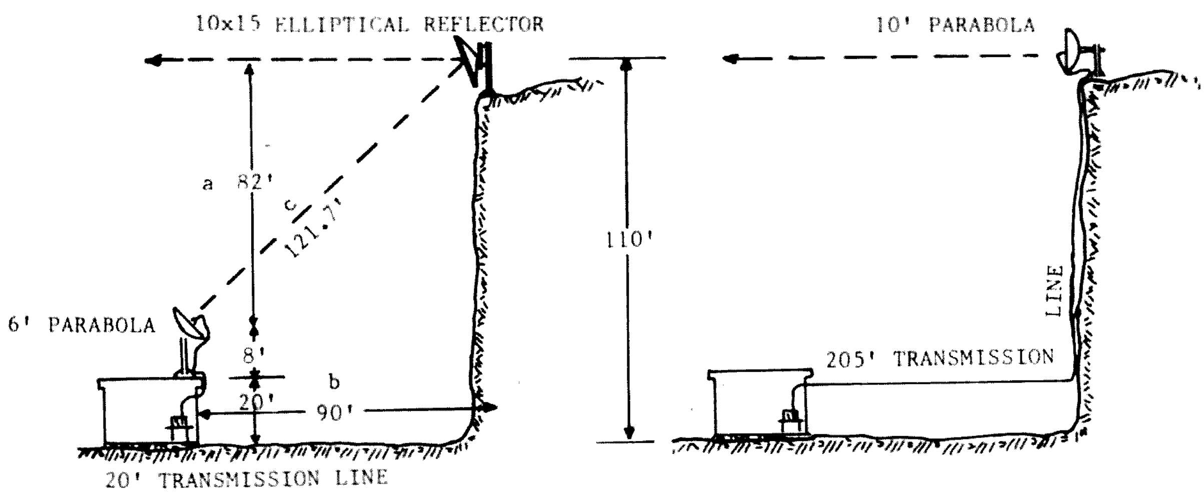


Fig. 1. Two methods of radiating a 2.3 ghz signal. "Periscope" system at left has effective antenna system gain of 31.1 db and is less expensive than its direct mounted counterpart which requires a 10' parabola and provides only 27.7 db gain. The example at left is often called a "Skewed" periscope shot.

Figs. 2, 3 and 4 take most of the work out of calculating the requirements of antenna-reflector combinations. Fig. 2 will be used in two basic ways. One way, using standardized size elliptically shaped reflectors and with the reflector mounted directly above the parabola (or any arrangement where the angle formed by the two beam paths is 90° ± 5°, (as shown in Fig. 5) will use the complete chart of Fig. 2. Assuming a 12x17 reflector, spaced 190 feet from a 6-foot parabola, and an operating frequency of 2.3 ghz, we would proceed as follows: Refer to Fig. 3. Determine the value of φ. With a 6-foot parabola and 12x17 elliptical reflector we will have a value of 0.5. Note this number and retain it for a moment. Going to Fig. 2, enter the graph on the bottom right hand side at 190 feet (the distance between reflector and parabola). Read up to the reflector size (12x17). At this point, read left horizontally until you intersect the curve corresponding to the frequency of interest, 2.3 ghz (curves for other frequencies may be computed using the formulas shown). Now, read vertically up until you intersect the φ curve corresponding to the number noted earlier (0.5). Again, reading horizontally to the left, read the gain or loss in db. Here, we will have about 0.1 db gain.

Adding up the gains and losses (remember, a 6-foot parabola has 29.9 db gain), we find the antenna system, with 20 feet of transmission line of the type previously mentioned, will give us a gain of 29.3 db. (29.9 db antenna gain + 0.1 db Near Field Gain − 20 feet coax at 2.3 ghz; 0.7 db).

As mentioned before, the above is to be used when the so-called "periscope" antenna arrangement is used. In offset arrangements, as in Fig. 1, it is necessary to perform a few calculations.

"Skewed" shot calculations

Using the parameters of Fig. 1 at 2.3 ghz there are three things we must determine before we can perform the necessary calculations. First, the slant distance from parabola to reflector. The old ($c^2=b^2+a^2$) method works very well here with the right triangle, and you will find that for Fig. 1 the distance is 121.7 feet.

With this distance determined we are ready to calculate the angle formed by the two paths (parabola to reflector and reflector to

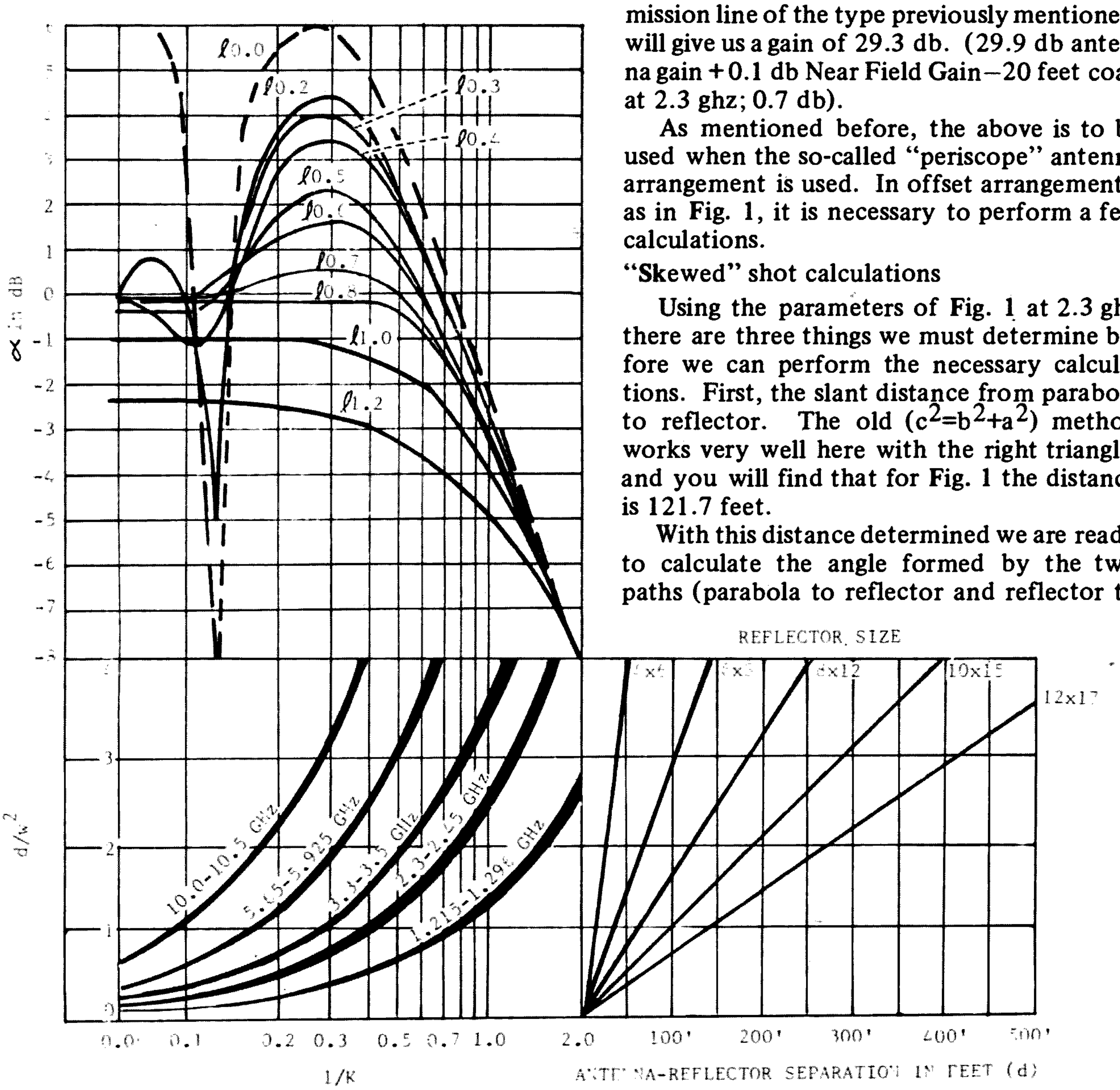


Fig. 2.

far terminal). Using the base line of 90 feet and the slant distance of 121.7 and working with the cosine function, we have cos Θ $\frac{b}{c} = \frac{90}{121.7} = .740$. Referring to a book of Trigonometric tables we find .740 is represented by an angle of 42° 44'. We refer to this as the vertical included angle.

With this angle determined, we can now calculate the final item required before getting into the real calculation of the antenna-reflector system.

The effective area of the reflector must now be determined. The effective area will be something less than the actual area depending on the angle at which the reflector is viewed by both terminal parabolas. Since the angle of reflection is equal to the incident angle, the angles for both paths will be the same and the effective areas in both directions will be the same.

To determine the effective area we use one-half the included angle. So, $\frac{42° 44'}{2}$ = 21° 22'. Then, referring again to the book of Trig tables, it will be found that the cosine of 21° 22' is .9313.

Now, we multiply the long axis of the 10x15 elliptical reflector by .9313 and this will give the effective length of the 15-foot dimension of the reflector. This is 13.97 feet.

Then, to determine the area of the ellipse, the following formula is applied:

$A_e = \frac{(a)\ (b)\ (\pi)}{4}$, where a is the 10' dimension, b is the 13.97' dimension and π is a constant value 3.14.

In this case we have:

$$A_e = \frac{(10)\ (13.97)\ (3.14)}{4} = \frac{438}{4} = 109.9$$

At this point, we will determine the value of 1/K. Once this has been done we enter **Fig. 2** directly at 1/K, ignoring both the frequency curve and the Reflector Size-Reflector Separation curve. Entering at 1/K we will read up to the appropriate φ curve and then read left to gain or loss in db.

$1/K = \frac{\pi \lambda d}{4\ Ae}$, where π is the constant 3.14, λ is the wavelength in feet (985)/(Freq. in mhz), d is the distance from parabola to reflector and, Ae is the effective area of the reflector at the angle of interest. In our case:

$$1/K = \frac{(3.14)\ \frac{(985)}{(2300)}\ (121.7)}{(4)\ \ (109.9)} = \frac{163}{438} = .381$$

Note this value, .381.

Determining the value of φ, so we can intersect the correct curve, is easy and is done as follows:

VALUES FOR $\ell = \frac{D}{W}$							
REFLECTOR (W)	ANTENNA SIZE (D)						
	2'	4'	5'	6'	8'	10'	12'
4x6	0.5	1	1.25	1.5	2	2.5	3
6x8	0.33	0.67	0.83	1	1.33	1.67	2
8x12	0.25	0.5	0.62	0.75	1	1.25	1.5
10x15	0.2	0.4	0.5	0.6	0.8	1	1.2
12x17	0.16	0.33	0.41	0.5	0.67	0.83	1

Fig. 3.

$\varphi = D\ \sqrt{4 \frac{\pi}{Ae}}$, where π is the constant 3.14, Ae is the effective area of the reflector and D is the diameter of the parabola.

Therefore:

$$=6\ \sqrt{(4)\ \frac{(3.14)}{(109.9)}} = 6\ \sqrt{.00717} = (6)(.0845)$$

= .508.

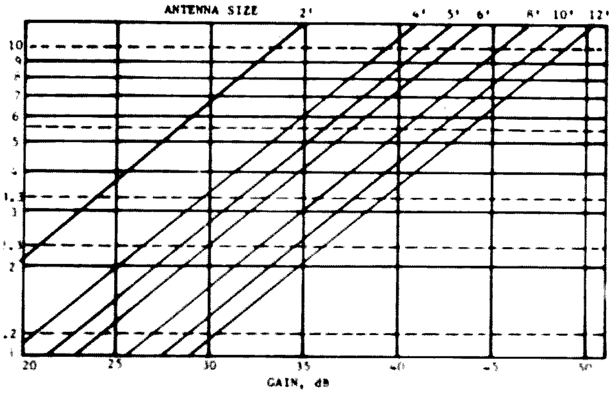
Now, entering the 1/K at .381, read up to where the φ curve is equal to .508. (You'll have to visually interpolate here a bit). Then read horizontally left and read 1.9 db gain.

Add 1.9 db gain to 29.9 db gain available from a 6-foot parabola and subtract the 0.7 db transmission line loss and you have 31.1 db antenna system gain which puts us almost back at the beginning of the article.

Elliptical reflectors versus rectangular reflectors

You'll notice that throughout the article, I've mentioned elliptically shaped reflectors. There is nothing to keep you from using a rectangular reflector. In fact, a rectangular reflector has about 20% more surface area than the elliptical reflector and will provide about 2 db more gain accordingly.

However, the elliptical reflector has the advantages of having lower sidelobe levels and sharper nulls between lobes, which are important considerations if you are troubled with co-channel or adjacent channel interference. In addition, the elliptical reflector offers 20% less surface area for wind loading purposes. Also, there is no reflection of unwanted Second Fresnel Zone energy with the elliptical reflector as might occur with the over-projecting corners of the rectangular reflector. The keep notch that occurs in **Fig. 2** where 1/K is about .13 is due to the reflection of Second Fresnel Zone energy. For optimum performance, 1/K should be designed around 0.3.



$= 20 \log_{10} (f) + 20 \log_{10} (D) - 52.6$
(f) is frequency in Megahertz
(D) is parabola diameter in feet.

Fig. 4.

Reflector face flatness

The reflector face should be essentially flat at microwave frequencies. The face must be flat to within 1/8 of the wavelength over the face of the reflector. If there should be deviations from flat (not to exceed 1/8 of a wavelength), the deviations must be concave rather than convex.

Deviations of about 3/4" over the entire face of the reflector can be accommodated at 2.3 ghz without appreciably degrading the signal. Various construction techniques may be used with the most successful being a cross ribbing technique.

Flat reflectors and gain

There is often some confusion, even in engineering circles, concerning how a flat surface can have "gain." Gain is usually defined as an increase (or decrease) over a predetermined level. The predetermined level serves as a reference point. In microwave antenna work the most common reference point has been established as the isotropic radiator (a point source). Sometimes a dipole will be the reference source, though. The dipole has a gain of 2.15 db referred to the isotropic source, so if conversions are necessary, that value should be used.

Any increase in aperture over the isotropic point source will result in more energy being radiated or redirected. Thus, the more energy, the more "gain."

Quite probably, the difficulty in realizing how a flat surface can have gain relates back to another popular misconception concerning parabolic antennas. This misconception is that it is the focussing effect of the parabolic antenna that provides "gain." Therefore, goes the faulty conclusion, since there is no focussing with a reflector that is flat how can there be gain?

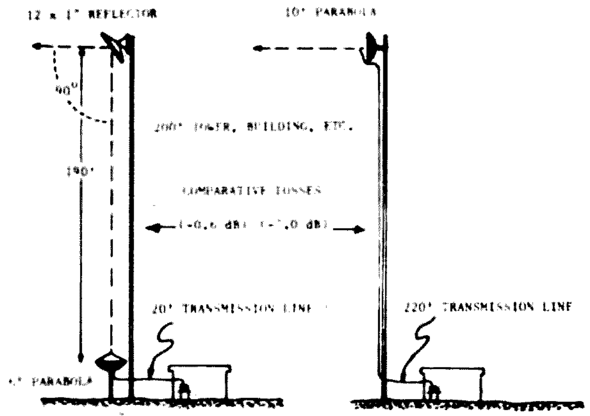


Fig. 5. Another example of the "Periscope" antenna system. A question often asked with regard to using small transmission lines (such as 7/8" diameter) is, "Why not go to a larger size coax to cut down on the losses?" There is nothing to prevent this except the economic consideration. As the transmission line gets larger in diameter and its loss goes down the cost goes up drastically.

The simple answer is that it is not focussing, as a characteristic of the parabolic antenna, that provides the gain. The focussing is merely a convenient means of transition from a large aperture (the dish) to a closely spaced small aperture (the feed device). It is projected aperture of the dish that provides the gain, not the focussing. Since it is the projected aperture that provides gain, the flat reflector, with its projected aperture, will provide gain which can be reliably calculated and measured.

Plane reflectors rather than back to back parabolas

Plane reflectors are extremely efficient devices. Commercial production line models have an efficiency of 99% as compared with the 55% efficiency of parabolas. So, if a passive repeater were to be made from a pair of back to back parabolas, the passive could be made from a plane reflector that would be about 6 db smaller.

As an example, a single 7x8 rectangular reflector will provide as much gain (with a horizontal included angle of 90° or less) as two 10' parabolas back to back.

A single reflector may be used where the angle to be turned is about 135° - 140° or less. With angles greater than that, the effective area is greatly reduced and efficiency of aperture drops off. Then, the common practice is to use a pair of reflectors closely spaced to get the "in-line" microwave beam over a hill or other in line obstruction. Depend-

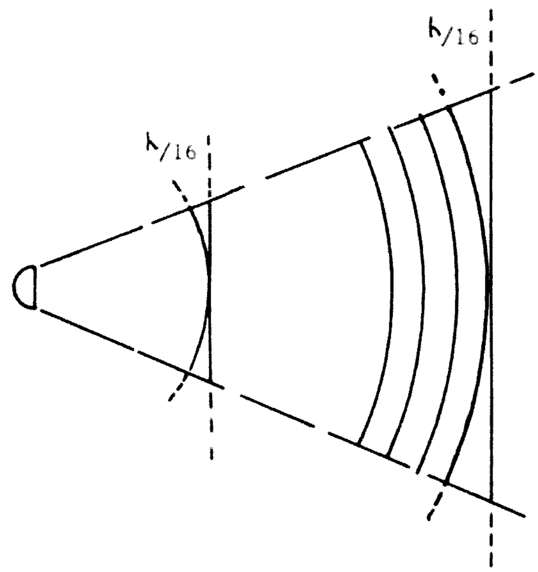


Fig. 6. What are near field and far field? The classical definition of the occurrence of near field is the point when a radiated wave (The microwave beam) intercepts a plane surface (the passive reflector) and the difference between any point along the radiated wave and the plane surface is 1/16 wavelength or greater. Note that either moving the passive reflector closer to the source or making the passive reflector larger can result in greating a near field situation. It will also be found that near field occurs when the computed value of 1/K is equal to 2.5 or less, i.e., 2.3, 2.3, 0.3, etc.

ing on the aperture of the reflectors, the operating frequency and the spacing between them, the coupling loss with the double reflector will be less than 1 db.

Conclusion

Reflector technology has been overlooked in amateur microwave work. Little emphasis has been given to it. With the development of microwave nets it would be a simple matter to interconnect many stations in an area where they normally would not enjoy line of sight and proper Fresnel Zone clearance. Use of reflector technology would eliminate the need for tall towers to provide proper path clearance.

Reflectors may be used at frequencies as low as 420-450 mhz. They may be used even at lower frequencies but unless the spacing is close and the reflector rather large, the aperture gains are somewhat low with the reduced frequency.

However, each situation should be mathematically calculated to determine whether or not it will perform. Use of any rule of thumb is to be avoided since no rule of thumb

can possibly include all the system design parameters and therefore no rule of thumb can possibly be accurate except by accident.
...W7EEX

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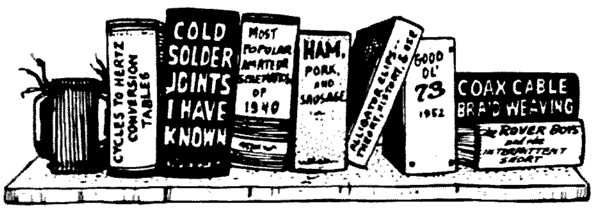


NEW BOOKS

How to Use Grid Dip Oscillators

Complete operating data on the uses of the grid-dip oscillator is contained in the revised second edition of this book by Rufus P. Turner. It tells in clearly written text with easy to follow diagrams and illustrations how to check LC circuits, linear and coaxial tanks, how to convert a signal generator or *rf* test oscillator into a GDO and vice-versa. It gives step-by-step instructions on measuring inductance, test and align TV, radio and FM receivers and how to find the resonant frequency of an antenna.

Another in the Rider series, it is available from Hayden Book Co., Inc., New York, or from your distributor. Price: $2.95 paperback.

How to Select and Install Antennas

While this book deals primarily with the selection and installation of TV and FM antennas, much of the information can be applied to ham vhf antennas. Construction and installation details are well covered. The various feedlines are discussed in detail. Lon Cantor, the author, has compiled years of experience in design and installation of vhf/uhf/FM antennas. He has written numerous articles on the subject for the leading electronics publications. One of the Rider series, How to Select and Install Antennas, is available from Hayden Book Company, Inc., New York, or from your local distributor. Price: $3.95 paperbound.

(. . .de W2NSD/1 continued from page 2)

New Magazine Planned

There has been rather continuous pressure for us to expand the coverage of 73 to include short wave listening and citizens band material. These are allied hobbies, I grant, and few amateurs have come into hamming other than through one or both of those avenues, yet I have felt that I would prefer to keep 73 a ham magazine pure and simple and leave CB and SWL coverage to others.

Those of you who are interested in SWL know that there has been all too little information published in this field. And, frankly, I am not impressed with the activities of some of the CB magazines. They seem to pander more to the base elements of the "hobby" than to try and provide leadership.

In all, I feel that there is a need for a magazine aimed at the beginning radio hobbyist. 73 is far too technical for the beginner and we need a magazine which can help the rank novice into the many interesting facets of radio and electronics hobbies. Accordingly, we are starting to work here at 73 to lay out the first few issues of a new magazine and I am hoping that the readers of 73 will support the idea since the basic scheme is to bring more people into amateur radio as an end result.

We will need articles. . .and plenty of them. This has made 73 successful and it just might work again. In the CB field we will look for articles on tests of commercial equipment. . .on simple accessories that can be bought or built. . .on antennas. . .mobile installations. . .articles of discussion of rules and proposed rule changes. . .the most basic of theory articles. . .reviews of books. . .discussions of good and bad operating practices . . .or anything else that you think would be of value to the CB operator. SWL's will be interested to read about new equipment, how to SWL with RTTY, with FAX, on TV . . .unusual SW stations. . .what to hear on different bands. . .police. . .ship-to-shore. . . aircraft. . .weather. . .news. . .etc.

Novice amateurs also need a lot of help toward their General Class license and they have been just about forgotten by everyone. We need articles on tests of Novice equipment. . .simple rigs for the Novice to build. . . accessories. . .discussions of operating on the various Novice bands. . .Novice contests. . . Novice DX.

Short wave listening can be a lot more than just sitting back and listening to Radio Moscow tell us what rotters we are. Although it is fascinating at times to listen to a country that has just sent their army into another country to subjugate it trying to tell us over the air that we are imperialist warmongers. Short wave listening today can include, it seems to me, tuning in directly on the satellites, the moon capsules, getting weather maps from satellites or from the weather services by facsimile, getting news, stock quotations, or whatever by Teletype, tuning for long distance stations down on 20 khz. Short wave listening can be more fun today than it ever was in the past, if only the information can be brought out on what is going on and how to get in on it.

CB, a dirty word to many amateurs, has a lot of possibilities too. I don't think it is really necessary to encourage illegal CB operations. A growing number of amateurs are using CB because it permits them to do some things that are not possible with amateur radio. If the abuses of CB could be discouraged the service would be of tremendous value. Many of us need a simple and relatively inexpensive communications medium for business and this means CB. Perhaps we would like to be able to keep in touch with the wife or family while working or driving not far from home. . .CB again.

If I were a newcomer into radio these days there is no question whatever that I would immediately get started on CB. This is a logical first step. Without encouragement I might get hung-up there and never get further. Thousands. . .or even tens of thousands are getting hung-up. Amateur radio has a lot to offer these fellows. . .and they have a lot to offer amateur radio. We need to urge them along. . .get them into our radio clubs. . .get them into theory and code classes.

As publication nears I'll let you know about subscription prices and when the first issue should be out. We're sort of aiming at this fall and I expect that the cover price will be 50¢ and the subscription rate about $5 for one year and $10 for three years.

The pay for articles will be a little less

than for 73. . .this reflects the smaller circulation, probably starting at about 25,000, and the simpler type articles involved. So, authors and prospective authors, make your hobby pay. . .write some articles.

Free Trip To Bermuda

The tenth annual Bermuda Amateur Radio Contest is upon us. Two free trips to Bermuda for both the CW and phone winners plus a week at the Carlton Beach Hotel add spice to this contest. Phone 0001 GMT June 22 to 0200 June 23, and CW 0001 July 20 to 0200 July 21. 80-40-20-15-10 meters. Three points per contact, multiplier one for each band, one for each Parish contacted. Logs to BARC, Box 275, Hamilton, Bermuda.

Visiting Switzerland?

Visitors to Switzerland may now obtain a three month temporary license by sending an application to Posts & Telegraphs Department, Berne, Switzerland together with a photo copy of your home station license.

Reciprocal Licensing

During the last year agreements were signed between the U.S. and Indonesia, Monaco, Ghana, Badbados, and Ireland. Denmark is still pending. The total is now 37 countries plus Canada.

73 vs Contests?

One of our readers wrote recently suggesting that 73 start running some contests. We have, so far, avoided this sort of misbehavior. I could be sanctimonious about it and point to the unending number of contests filling our bands with fruitless QRM. However, looking at the other side of the coin (a nasty practice of mine), the reason our bands are so filled with contest activity is that so many operators have fun that way.

Wouldn't it be fun, methinks, if some reader could come up with a corking good new DX contest? It would be even more fun if a serious DX'er (whatever that is) or a DX club would volunteer to run a DX contest. You know, score the logs, send out the certificates, and all the hard work. I suspect that I could put in a good word and get 73 to publicize the contest, provide the certificates, some postage money, and run the top winning score. Perhaps there is really nothing new in DX contests possible? I wonder if there really is any way to set up the scoring so that ops in different countries have a relatively equal chance of winning? Probably not.

Or might there, perchance, be a club or even one fellow with one hell of a lot of time and energy who would like to run a neverending set of state QSO parties? Not likely. Just imagine, without boggling your mind, starting with Alabama in January and having a contest every lousy weekend until Christmas, ending with Wyoming. Maybe a snappy twelve hour panic, starting at noon and ending with the Cinderella chimes each Saturday. And how about a giant all-state QSO party during Christmas week? Boggled on that, eh?

Now that the good old CQ VHF contests have dried up and blown away all we have are those three time dishonored QST VHF contests. Are they enough? Are they too much? Or should we put on our little old thinking cap and work up a fascinating new set of rules for a contest along in July? And maybe one during Christmas week for those not interested in working all states? Only if you think up the rules, the scoring, take care of the logs, fill out the certificates, and write up the results for 73. Otherwise send the idea over to one of the other ham magazines and let them botch it up.

. . .Wayne

FCC RM-1311

The present regulations permit an Extra Class licensee who has been licensed at least 25 years to apply for a two letter call. The FCC now proposes to accept licenses issued by foreign governments at least 25 years ago in addition to FCC issued licenses.

One must have had a license better than a Novice or Technician grade for two years before he can apply for an Extra Class license. The FCC now proposes to accept foreign issued licenses equivalent to the General Class or better as well as FCC issued licenses.

Comments, pro and con, should be sent to the FCC before July 25th and replies to those comments are due by August 11th. Original and 14 copies, as usual.

Ralph Hanna, W8QUR
3023 Emmick
Toledo, Ohio 43606

A VFO for the Heath HW 18-3

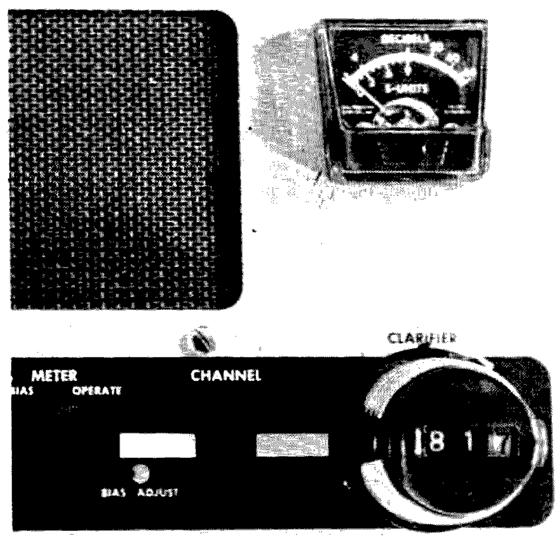
Even more fun on 160M

In my recent article on the Heathkit HW 18-3, it was pointed out that a VFO would be a very nice addition to this excellent 160 meter SSB transceiver. I used the LMO in the SB 100 with such good results that I decided it would be real nice to build a VFO of some sort right into the HW 18-3.

The pictures show the results. The one with the digital dial is real nice if you insist on direct reading of the frequency. This is not easy and the dial is not cheap. The other dial makes a very neat looking installation with a minimum of cost. Everything that is needed for $3.00. The only drawback is that this method uses the clarifier capacitor and linear readout is impossible. A tuning table or graph can be made that will be accurate to a half khz. To get a good band spread, a 22 picofarad capacitor is used in series with the clarifier capacitor as shown in the wiring diagram. This allows the rig to be tuned over any 100 khz segment. Since the whole set must be retuned for anything else, this was considered the best way.

The added capacitors were all mica. I used what I had but 500 volt would be suitable. The original capacitors were not removed and the new ones were soldered directly to the foil side of the board. 100 picofarad capacitor is (or was) c 211 that was in series with clarifier capacitor.

The coil is 15 turns of No. 28 wire on a Miller nylon slug tuned coil form. Any material is OK for the coil. I do not recommend nylon for anyone doing much experimental



This inexpensive digital dial readout is nice.

work as they melt very easily. The slug is used to bring the VFO into the operating range and this makes it easy to adjust. I reamed one of the holes in the subpanel you put the screwdriver through to tighten the slide switches in place.

Once all the parts are installed, it is a simple matter to adjust the slug to receive (and transmit) on the lowest frequency to be used. If you have a frequency meter such as a BC 211 or a Navy LM, then you have no problem. You can either feed in a signal from 1800 khz to 2000 khz or, better yet, listen for the oscillator in the freq meter. I say this because at 1800 khz range you are working with the 5th harmonic and may pick the wrong one. There is no question in the 5 mhz range as this is the second harmonic

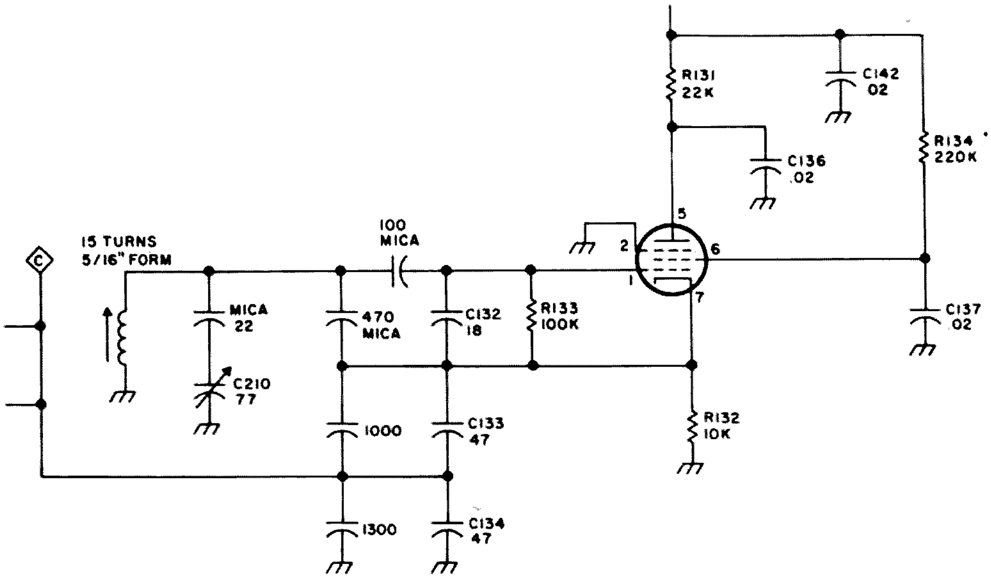
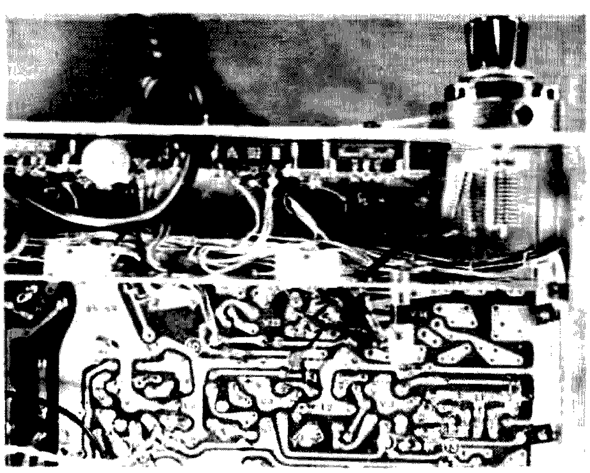


Fig. 1. VFO circuit for HW18-3. Simple. Works.

of the high range of the freq meter. If you use the high range then for 1800 khz the oscillator will be at 5.1935 mhz. At 1900 khz it would be 5.2935. With this information you can easily figure the other settings for the freq meter.

If you do not have a freq meter then you can do fairly well with a broadcast receiver that you can assume is aligned fairly accurately at an IF of 455 khz. Place the receiver close to the antenna of the HW 18-3 and tune in a station as close to 1345 khz as you can. The BC receiver oscillator will be very close to 1800 khz. 1445 khz on the BC receiver gives 1900 khz. In between points can be selected by adding 455 khz to the BC frequency. Of course, if you have a receiver with a 100 khz calibrator then you can use this. Connect the HW 18-3 antenna connect-



VFO installed in HW18-3.

or directly to the receiver antenna post.

The direct read-out dial takes a lot of work to get the values of the capacitors right. The capacitor I used was one from an HW 12 that had a 4 1/2 to 1 planatary drive. Since the capacitor only turns 180 degrees, the dial read-out about 225 digits so that by putting a figure 1 on the case read-out was direct in khz. The big problem is adjusting the capacitors to cover the range exactly. The capacitor used was 47 picofarad with an 8-30 picofarad for final tuning. You've got to juggle back and forth between this and the coil slug to get perfect tracking but it can be done.

The little planatary drive (Lafayette 99 H 6031) works real well and so as not to drill any holes in the panel, a spacer was made 2 inches in diameter with a 1 inch hole about 1/2 inch thick. A thin metal plate was attached to the back with countersink screws. The dial is attached using only the two bottom screws. The spacer and plate are held on by the nut holding the capacitor. A 5/16 inch hole was bored in the bottom of the spacer to get in to tighten the set screw on the shaft.

I am sure that once you have made this addition to the HW 18-3 you will find a whole new world of fun on the "top band."

. . .W8QUR

IC Breadboards

While working with Integrated Circuits, I soon found that some means of mounting the IC's had to be devised because: (1) the leads on an IC are much too small to work with conveniently; and (2) if I soldered directly to the IC, I would probably have destroyed it after a small amount of experimenting, because of the heat. I was fortunate because my first contact with IC's was through Kaye Engineering's integrated circuit kit which contains two Fairchild uL914 and two printed circuit mounting boards. The PC mounting boards are my concern here. Fig. 1 left shows one of the boards (and its IC) contained in this kit. Fig. 1 center shows a homemade PC mounting board with a 14 pin IC on it. This board is hard to work with because of the small width of the copper strips to the middle pins. The board shown in Fig. 1 right is a solution: by curving the copper strips there are large soldering pads for each pin.

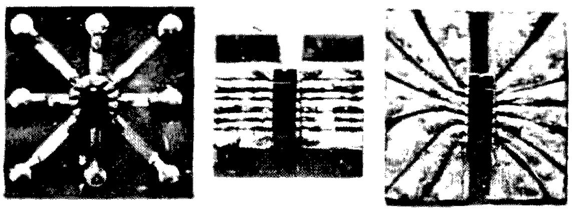


Fig. 1.

The boards are easy to duplicate. The left board can be made from a 2" by 2" piece of copper clad board, a few inches of 1/8" wide resist tape, and eight resist circles. Set it up as in the picture and etch. The center board was made by scoring through the copper on a piece of PC board and pulling off the unwanted copper foil. This is the least messy method of making these boards and can be used, if instead of soldering parts directly to the PC board, wires are used to connect from the PC board to the external circuitry. The left board was made using Scotch tape to cover the areas of foil that are wanted. Set it up as in the picture and etch.

I have shown boards for only two types of IC cases; but by using the same techniques, boards can be made for any size and shape IC. You will find these IC PC breadboards will make experiments and projects using IC much easier.

Richard Roth, WB2UMH

A Whip Antenna Add-On

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Various simple "add-on" attachments for vhf mobile whip antennas are described which can be used to modify the directive pattern or even the radiation polarization of the basic antenna. Most of them provide a significant gain factor.

Often one wishes to mount only a simple whip antenna on an automobile for use on vhf bands. Such an antenna suffices in many cases for local contacts while "in motion," especially in large city areas. However, when outside the local area and especially when the automobile is stationary, one often requires or can utilize a more effective antenna if any contacts are going to be made with reasonable signal levels.

One can take two approaches towards this type of antenna problem. The one approach used by many vhf mobile enthusiasts for stationary hill-top operating is to pack along a full-size beam and mast. Unpacking, assembling, connecting, etc. of such an antenna can be quite a chore. Of course, the results are often worth the effort as far as vhf dx is concerned. The other approach is to utilize some form of auxiliary antenna structure which can simply and quickly be attached to the mounted whip antenna whenever the automobile is stationary. A number of problems arise when one tries to devise such an auxiliary antenna structure. It must provide a significant improvement in antenna performance, not upset the matching conditions to any great degree to the whip antenna, be relatively simple in construction and yet attach to the mounted whip in much the same fashion as a cap is put on a bottle – a rather tall order.

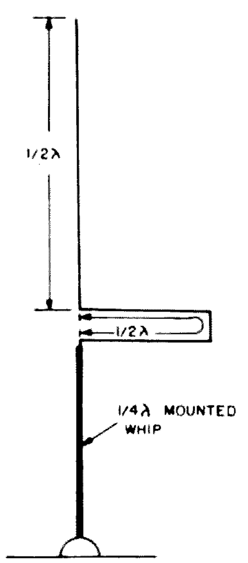

Fig. 1. Addition of phasing stub and ½λ radiator to basic ¼λ whip retains vertically polarized radiation, omnidirectional in the horizontal plane but with about 3 db gain in the vertical plane.

This article discusses some of the problems that are involved in devising such an auxiliary antenna "add-on" structure. Several designs are presented, but none of the designs will instantly transform a simple mobile whip into the equivalent of a 10 element beam. The determined vhf hill-top dx enthusiast will still have to take along his beam for best results. However, the "add-ons" described will significantly improve antenna performance under specific conditions, and they really are as easy to use as putting a cap on a bottle.

Basic Considerations

Adding an auxiliary structure to a ¼λ whip mounted in the middle of the roof of an automobile has certainly been done before. **Fig. 1**, for instance, shows the addition of a ½ λ element to the basic ¼ λ whip. The phasing stub is necessary to insure the same direction of current flow in the ¼ λ and ½ λ radiating elements and, therefore, prevent the vertical radiation pattern from splitting and sending most of the radiation out at useless high angles. Otherwise, the

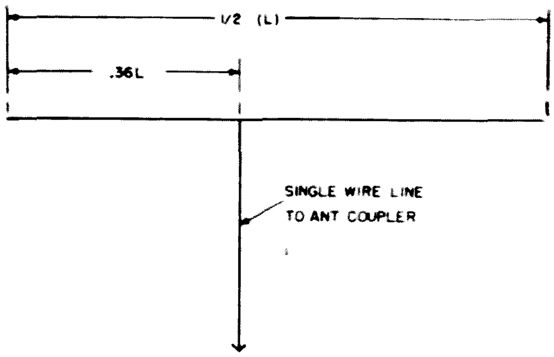

Fig. 2. Old style window antenna. Its single wire feed system idea is used as the basis for other antenna types shown.

phasing stub need not be used as far as impedance matching the added ½ λ element to the basic whip is concerned. The phasing stub itself can be formed of stiff wire rod wound in a circle around the vertical elements. A gain of about 3 db will result but the radiation will still be vertically polarized and omnidirectional in the horizontal plane. One can extend this design to as many elements as desired but the basic radiation characteristics will not change, except for gain in the horizontal plane.

Another concept is necessary to modify the performance of the basic whip antenna. The concept which the author developed is based upon the old Windom antenna idea (Fig. 2). Old-Timers will remember this form of off center fed dipole very well. It used a single wire feed line which represented about a 600 ohm feed system using an earth return path for the "missing" half of the usual 2 wire feed line. Due to the earth return path, it performed best over earth of high conductivity.

The usual mobile mounting of a vhf antenna provides an excellent high conductivity ground path via the automobile body. So, ground conductivity is not a problem in adopting the "Windom" feed system concept to a mobile whip. What is different, however, is the impedance relationships. The "Windom" feed line was connected to the dipole flat-top at a point off center which provided about a 600 ohm impedance. The transmitter end of the feed line was connected to an antenna coupler set to match the feed line impedance. If the ¼ λ mobile whip is visualized as the "Windom" feed line, it does not match the impedance of the coaxial feed line to which one end is attached. The only way the impedances will match is if the ¼ λ whip-turned "Windom" feed line also acts as a ¼ λ transmission line impedance transformer between the coaxial transmission line and the antenna structure which it feeds. This requires that the antenna structure (the whip "add-on") present a very high impedance at the point of connection.

Typical "Add-On" Designs

If one understands the feed system concept explained in the preceding paragraphs, it is possible to study antenna manuals and find many designs that could be used as whip "add-ons." The few that are presented here are relatively simple and seem to work well.

Fig. 3 shows two configurations. The Spider-Leg (A) provides mainly horizontally polarized radiation with a bidirectional radiation pattern centered on the intersection of the legs. The horizontally polarized radiation could be further emphasized by keeping the entire length of the legs mount-

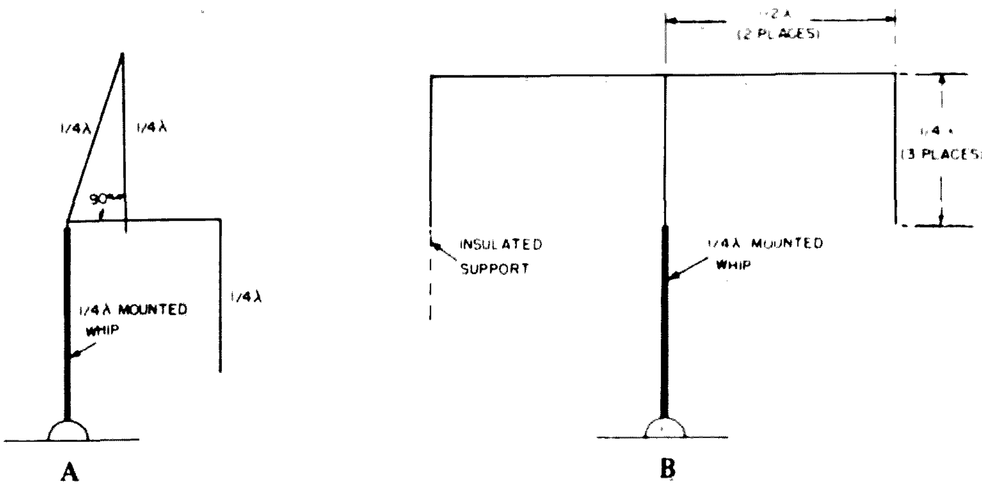

Fig. 3. "Spider-leg" configuration (A) provides combination horizontally and vertically polarized radiation. Modified "bobtail" configuration (B) produces quite directional vertically polarized signal.

ed horizontally. Although it was not tried, some gain in the horizontal plane could possibly be achieved by making the legs longer in multiples of ½ λ.

The modified "Bobtail" antenna of **Fig. 3** (B) produces a vertically polarized signal but one with a fairly good amount of gain (about 7 db). The radiation is bidirectional and broadside to the array (in and out of the page as the antenna is shown).

Fig. 4 shows a more elaborate "Zig-Zag" "add-on". In spite of its appearance, the radiation produced is mainly horizontally polarized with several db of gain and a bidirectional radiation pattern. Due to the current reversal that takes place every ½ λ, the vertical components cancel while those in the horizontal plane enforce each other. If found more convenient structurally, the antenna can be mounted with the first element horizontal to form a staircase outline, but this would result in the production of some vertically polarized radiation.

Although not tried, it would seem to be feasible to form beam antennas by placement of parasitic elements either in front of or in back of the main antenna. The spacing would have to be kept fairly wide (¼ λ or more) in order not to appreciably lower the feed point impedance of the main antenna since there is no way to adjust the "match" to the main antenna.

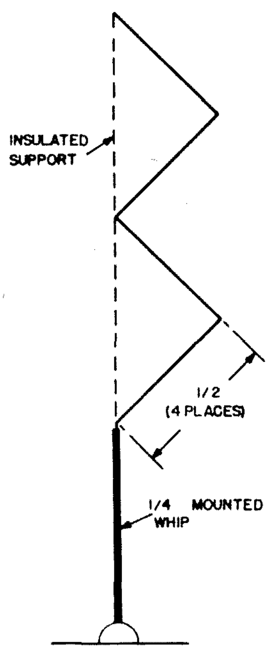

Fig. 4. "Zig-zag" configuration provides directive horizontally polarized radiation. Two sections are shown but only one may be used, if desired. The gain will be reduced but the polarization will remain horizontal.

Construction

Depending upon how durable one wishes to make an "add-on," it can be constructed from anything from No. 8 to No. 10 wire to 3/16" or 1/4" duraluminum rod. It is suggested that for initial experimentation, the "add-on" be constructed from heavy guage wire with wooden or plexiglas rods used for insulated support structures when necessary. The "add-on" can be secured to the whip by a variety of means from clips to clamps. One of the handiest found by the author was the use of electricians' small U-shaped cable clamps, available in most large hardware stores. The "add-on" structure made of wire can be soldered to the flat side of the U-clamp surface.

An swr meter should be inserted in the coaxial transmission line to the whip to determine the effect upon swr when the "add-on" is used. Generally, the swr should not change to any great degree. It may, in fact, even improve slightly in some cases, depending upon how good the original match was, by canceling some reactive components.

The improvement in performance can be checked with another station by simple comparison checks. When making such checks, however, due consideration should be given to the fact that some "add-ons" will change the polarization characteristics of the radiated signal. Therefore, the station with which checks are made should have available an antenna that will match the polarization of the radiated signal. If this is not observed, very confusing results will occur as in short distance line-of-sight contacts, an antenna polarization difference between stations can easily produce a 20 db loss in the received signal.

Summary

The convenience of being able to simply add a few elements to a whip antenna and modify or improve its performance without readjustments or disturbing transmission line connections is difficult to describe. One is inclined to stop the automobile for contacts just so the "add-on" can be used.

As was mentioned before, many variations of the "add-on" described are possible. It is not claimed that they are the best that can be devised and the reader should experiment with various designs - following the concept presented for using the basic whip antenna as the equivalent of a singlewire feed line.

. . .W2EEY/1

PROPAGATION CHART

J.H. Nelson

July 1969

SUN	MON	TUES	WED	THUR	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Legend: Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7A	7	7	7	7A	14	14	14	14
ARGENTINA	21	21	14	14	14	7	14	14A	21	21	21A	21
AUSTRALIA	14	14	14	14	7B	7B	7	7	7B	7B	14	14
CANAL ZONE	21	14	14	14	7A	7	14	14	21	21	21	21
ENGLAND	14	14	7A	7A	7	14	14	14	14	14	14	14A
HAWAII	14	14	14	14	7B	7B	7	14	14	14	14	14
INDIA	14	14	7A	7A	7B	7B	14	14	14	14	14	14
JAPAN	14	14	14	7A	7B	7B	7B	14B	14	14	14	14
MEXICO	14	14	14	14	7	7	14	14	14	14	14	14
PHILIPPINES	14	14	14	7B	7B	7B	7B	14	14	14	14	14
PUERTO RICO	14	14	14	7A	7	7	14	14	14	14	14	14
SOUTH AFRICA	7B	7B	7B	14	14	14	14	21	21	21	14	14
U. S. S. R.	14	7A	7A	7	7	14	14	14	14	14	14	14
WEST COAST	21	21	14	14	7	7	7	14	14	14	14	14

CENTRAL UNITED STATES TO:

ALASKA	14	14	14	14	7A	7	7	7A	14	14	14	14
ARGENTINA	21	21	14	14	14	7	14	14	14A	21	21	21
AUSTRALIA	14	14	14	14	14	7A	7A	7A	7B	7B	14	14
CANAL ZONE	21	14A	14	14	14	7	14	14	14	21	21	21
ENGLAND	14	14	7A	7A	7	7B	14	14	14	14	14	14
HAWAII	14	14	14	14	14	7A	7	14	14	14	14	14
INDIA	14	14	14	7A	7B	7B	7A	7A	14	14	14	14
JAPAN	14	14	14	14	7B	7B	7B	7A	14	14	14	14
MEXICO	14	14	14	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	14	7B	7B	7B	14	14	14	14	14
PUERTO RICO	14A	14	14	14	7	7	14	14	14	14	14A	14A
SOUTH AFRICA	7B	7B	7B	7B	7B	14	14	14	14	14	14	14
U. S. S. R.	7A	7A	7A	7	7	7	14	14	14	14	14	14

WESTERN UNITED STATES TO:

ALASKA	14	14	14	14	7A	7	7	7	14	14	14	14
ARGENTINA	21	21	14	14	14	7	14	14	14A	21	21	21
AUSTRALIA	21	21	21A	21	14	14	14	14	7	7	14	21
CANAL ZONE	21	14A	14	14	14	7	14	14	14	14	21	21
ENGLAND	14	14	7A	7A	7	7B	7B	14	14	14	14	14
HAWAII	21	21	21A	21	14	14	14	14	14	14	14	21
INDIA	14	14	14	14	7A	7B	7B	7A	14	14	14	14
JAPAN	14	14	14	14	14	14	7	7A	14	14	14	14
MEXICO	14	14	14	14	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	14	14	14	7B	7B	14	14	14	14
PUERTO RICO	14A	14	14	14	7	7	7A	14	14	14	14A	14A
SOUTH AFRICA	7B	7B	7B	7B	7B	7B	7A	14	14	14	14	14
U. S. S. R.	7A	7A	7A	7	7	7	7	14	14	14	14	14
EAST COAST	21	21	14	14	7	7	7	14	14	14	14	14

A - Next higher frequency may be useful this period
B - Difficult circuit this period

"I've been going nuts trying to eliminate that tweeting noise in it!"

2N5188 Two-Meter Exciter

Frank C. Jones, W6AJF
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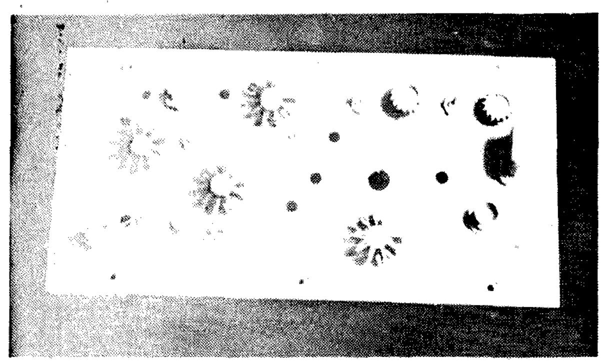
The RCA 2N5188 power transistor is a recent type rated at 4 watts maximum dissipation and is available for 55 cents apiece. It was designed for core-driver and line driver as well as class C *rf* service. Its f_t of 325 mhz means it will operate well up thru 50 mhz in class C operation, and fairly well up thru the 144 mhz or two meter band. Some 2N5188 transistors are better at 144 mhz than others, so the "hotter" ones should be used in the last two stages of the exciter illustrated here. These transistors were used throughout the exciter.

The 2N5188 has a maximum rating of 25 volts from collector to emitter, and 5 volts from base to emitter. The maximum power rating of 4 watts is for a case temperature of 25° C. Allowing for some temperature rise (at a derating of 23 mw per ° C) and the use of small heat radiators, still means that about 1 to 2 watts input can be run into these transistors. In this exciter, the output amplifier runs about 1 to 1¼ watt input with from .4 to .5 watt output on CW, with a 12 volt battery power supply. An 18 volt supply and large heat radiator should result in more than one watt output. CW keying probably could be done in the base bias resistor return connection to ground of any stage or two stages.

The 2N5188 output amplifier was compared with 2N3512 and 2N3553 transistors. The latter was about 20% better in output at 148 mhz but cost about nine times as much as the 2N5188. The 2N3553 isn't too effective with a 12 volt supply, being designed for 28 volt operation, so these tests at 12 volts weren't really fair to the 2N3553 costing nearly $5 each.

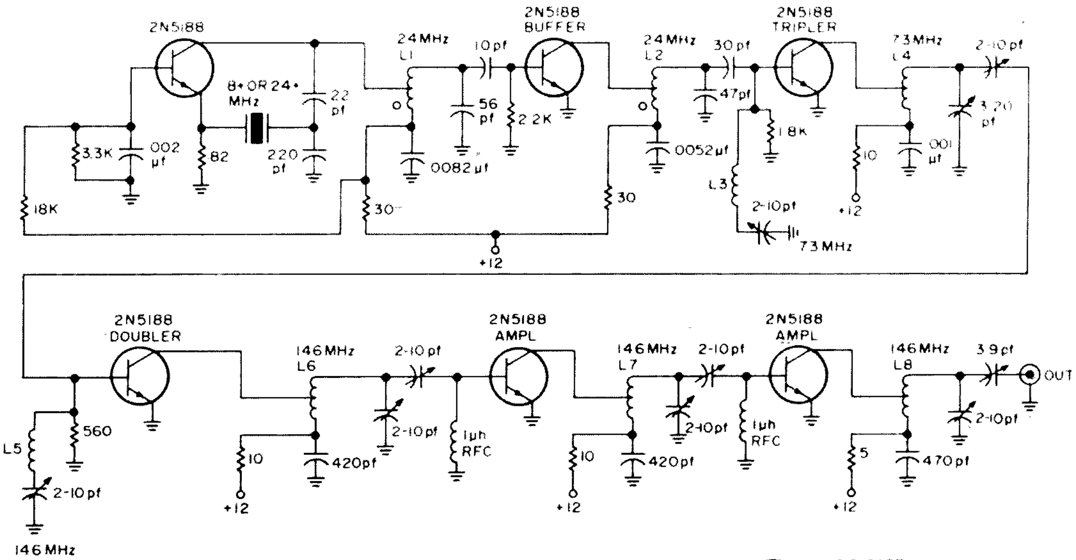
The *rf* exciter shown in the photographs



Top view of 2N5188 exciter. Crystal oscillator, buffer and tripler along the top of the 8x4" copper plated board. The doubler, buffer and final amplifier are toward the lower edge.

and in the circuit diagram, was built on a piece of copper plated bakelite or epoxy board 4x8 inches in size. This fits into a 4x8x2 inch chassis as a bottom cover and shield can. The copper plating makes a good ground surface for mounting small variable condensers and can be soldered to with a 25 or 50 watt soldering iron. By-pass condenser and emitter leads should be very short to help maintain stability.

Two types of heat radiators were used on the transistors. Both types are snug fitting on the TO-39 transistor case. The "fin" type is less expensive unless one happens to find the smaller "ribbed" type in the surplus market. The two ribbed units shown in the top view are surplus radiators or coolers and were used on the oscillator and buffer stage. The first two transistors do not require a cooler since their collector current runs between 15 and 30 ma, at 12 volts, but the following tripler, doubler and amplifiers do warm up and need one type or the other. The collectors are connected to the TO-39 case, so a large cooler or radiator does increase the 8 pf output capacitance somewhat. This effect can be taken care of in the circuit design.



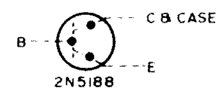


Fig. 1. Schematic of the 2N5188 exciter.

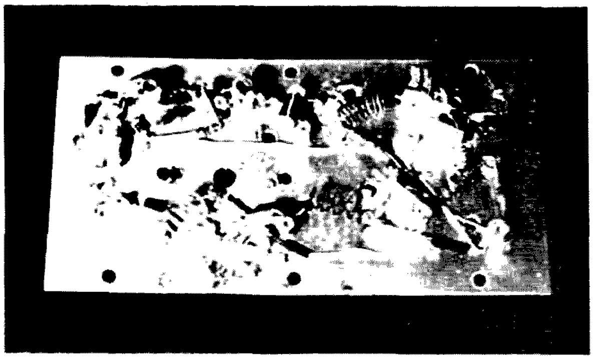
L1-L2 10 turns 22 enamel 5/16" long, ¼" diameter. Fr. slug coil form.
L3 20 T 24C, ½" long by ¼" diameter poly rod form.
L4 10 T #18, 3/4" long ¼" diameter tap 3 turns up.
L5 10 T #24C, ¼" long by ¼" diameter poly rod form.
L6 6 T #18, 3/4" long, ¼" diameter tap 2½ turns up.
L7 6T #18, 1" long, ¼" diameter tap 2 turns up.
L8 5T #14, 5/8" long, 5/16" diameter tap 1 turn up.

The 2N5188 transistors were found to be quite stable at two meters in grounded emitter circuits, without any form of neutralization. Tapping the collector leads into the lower end of each coil can be used for impedance mismatching to eliminate the need for neutralization, and also to provide a fairly high Q tuned circuit. The output load resistance of the 2N5188 varies over a range of from about 600 ohms down to about 100 ohms in this exciter, depending upon the dc collector current. The base to emitter impedance is lower, ranging from about 50 ohms down to 25 ohms. These low values can be matched to the tuned circuit values of 1000 to 2000 ohms by either using adjustable link coupling or by small coupling capacitors. The latter method was used in this exciter. The total C and L values in each circuit were chosen to have a Z of from 15 to 25 in order to reduce unwanted harmonics with only a single tuned circuit between each stage. Many circuits shown in transistor handbooks and in some magazine articles, are so heavily loaded by the transistors that the operating Q may be closer to 3 than to the 15 or 20 needed for harmonic suppression. A tripler should be used as a tripler not a combined doubler, tripler and quadrupler, since only the tripled frequency is useful. The same reasoning holds true for doubler and amplifier stages.

The crystal oscillator is a type that will function with either 8 or 24 mhz crystals for output at 24 mhz. The slug tuning adjustment is more critical with 8 mhz crystals than with 24 mhz overtone crystals. The buffer stage was lightly coupled to the oscillator to insure good oscillation starting ability with 8 mhz crystals. Both types of crystal were tested in the exciter with good results in either case.

A buffer stage at 24 mhz was needed in order to drive the tripler stage to 72 mhz, or higher. The tripler stage requires a higher value of base bias resistance than for a doubler. The rule used here was to try different values in each stage so as to produce enough *rf* drive to the next stage, but not run into the problem of too high a peak voltage across each base to emitter. Remember, the absolute maximum base voltage on these transistors is 5 volts, so often low values of resistors, or none, (only a *rf* choke) is required in each stage.

The doubler and tripler stages function by waveform distortion across the base to emit-



Bottom view of 2N5188 Exciter. Crystal oscillator at upper left and 2 meter stages near bottom side. See text for explanation of extra holes.

ter bias resistor. This means that there is double and triple frequencies in the input side of these transistors and a low impedance path is needed, just as in a parametric doubler using varactors. Small high Q series tuned LC circuits were connected from base to ground in each frequency multiplier stage. The output power increases greatly as these circuits are series tuned to resonance with the transistor output circuit also tuned to resonance. This effect is particularly noticeable with low power supply voltage and low driving *rf* power in each stage. The 2N5188 is a double diffused epitaxial planar transistor of the silicon NPN type, not too far different from a varactor diode. Probably some parametric frequency doubling action takes place since a straight doubler or tripler generally has very low *rf* output at low supply voltages.

Small German-made ceramic (low cost) trimmer condensers were used for these series tuned circuits as well as for coupling and parallel tuned two meter collector circuits. These condensers have high enough Q and mount easily, or they can be suspended by heavy leads but do not tune smoothly when there is much *rf* current flowing through them. Small Erie or CRL adjustable flat circular types might be used. Other piston type trimmer condensers are available, but are more expensive. The German mass-produced units may not be available in radio stores, so substitution may be required in constructing this type of exciter.

Standard sized red coded ferrite slug coil forms were used in the oscillator and buffer stages. Number 18, 16, or 14 wire was wound over a ¼" and a 5/16" diameter steel drill as a temporary winding form for the higher frequency circuits.

The coil data is listed in a separate part with the proper tap points for 12 volt operation. 15 or 18 volt supply may require a little change in coil tap position and in the values of bias resistors throughout.

The output circuit is matched to a 50 ohm load with a small 3.9 pf fixed condenser but another 2 to 10 pf trimmer (or 2.5 to 7 pf) would be advisable in this position in order to couple the output into an antenna coax line or into 75 or 93 ohm coax lines to a larger amplifier stage. A tube, or a larger *rf* power transistor might be driven with the ½ watt output available from this exciter.

The parts layout starts with the crystal socket and progresses along one side of the 8x4" board and back again along the other 8" side, leaving ½" clearance on all sides. This permits the unit to be fastened to the lips of an 8x4x2 inch chassis. The extra holes in the copper plated board were not for ventilation, but resulted from numerous circuit changes and ideas tested along the way. Some people might suggest these were design errors but that is too close to the truth to be admissible by a true experimenter.

Tune up is not difficult if a 0 to 300 or 500 ma meter is connected into either the - or + leads to the battery. All stages will draw very little current, except for a few ma in the oscillator stage since it has some + bias on the base to make the stage start oscillating easily. As soon as the crystal oscillator coil is tuned correctly the dc meter reading will increase from about 12 or 15 ma to 30 or 40 ma even if all other stages are detuned from resonance. Then as each stage in turn is tuned to resonance, the dc meter reading will increase. The total dc reading will be over 200 ma when all circuits are correctly aligned for maximum output reading into a one or two watt *rf* wattmeter. A 50 ohm 1 watt resistor termination across the output jack and a diode *rf* voltmeter (5 volt range) across the resistor may be also used for reading *rf* output. Even a nearby two meter receiver S meter may be used to tune up the exciter into some form of dummy load. Nearly all circuits have to be adjusted carefully and the variable stage coupling condensers readjusted for getting maximum output. Too much capacity in these coupling condensers will lower the Q of

the tuned circuits too much for good spurious signal suppression. Too little will mean less output. An *rf* meter in the output of the exciter will measure spurious as well as desired frequencies. The two meter receiver S meter is a selective device reading only the desired frequency. If the various adjustments do not result in agreement on the two *rf* metering systems, one can suspect spurious oscillation or excessive harmonic power in the output system. The adjustments for maximum radio receiver and *rf* wattmeter or diode voltmeter readings should be the same. If not, start reducing coupling capacity values and retune each circuit for resonance and maximum output.

Some 2N5188 transistors have better gain at two meters so these can be used in the two meter amplifier stages. The lower frequency stages are much less critical so the weaker transistors can be plugged into these parts of the circuit. It probably has to do with the cut-off frequency of each transistor, since 148 mhz is getting pretty close to the average ft of 325 mhz. At a cost of 55 cents each, an amateur shouldn't expect perfection in each transistor. The writer has seen nearly similar variations in the $5 types of transistors.

...W6AJF

Getting Your Extra Class License

Part VI - Noise

Staff

One of the most annoying problems in radio communications is that of noise; many volumes have been written on various aspects of this problem. As a result, a good understanding of the noise problem is a pretty fair indication that the person having it also has a good understanding of radio communications—and so the Extra Class examination study list includes a number of questions dealing with this problem.

Now that we have fairly well digested the subject of antennas, in our previous two installments, let's move on to the noise questions, and devote this installment to them. In addition, let's examine receiver detectors—which are, in practice, closely connected with the noise problem.

The specific questions from the FCC list which we will examine are:

3. How may a limiter be employed in an FM receiver?

23. How can you distinguish between a product and an envelope detector?

24. How can a receiver be adjusted for single sideband reception when the receiver does not have a product detector?

27. Where in a receiver circuit should a limiter/blanker stage be placed to provide maximum utility?

43. What are some different types or sources of noise voltages in reception? How is each type generated?

57. Of what importance is the signal-to-noise ratio of a receiver? At what radio frequencies is this ratio most important?

As usual, let's substitute for the specific FCC questions other questions of somewhat broader scope, so that we won't be limited in our studies to specifics but instead will be able to take a more general point of view.

Since our major subject this time is "noise," a good starting point would be to ask, "What is noise?" Then we will be in position to determine, "What does signal-to-noise ratio mean?" as well as "How is noise reduced?"

We can then turn to our secondary subject for this installment and inquire "How are signals detected?" Here we will see how product and envelope detectors differ, among other things, and how to use both. Finally, we'll try to find out, "How does FM reception differ from AM?"

Ready? We're off!

What is Noise? In radio—or, for that matter, throughout science—the word "noise" has almost as many meanings as it has users. One of the first paradoxes to result directly from this multiple meaning which most of us meet is the fact that a noise limiter will do almost nothing to limit thunderstorm noise. A similar paradox is the fact that installation of a low-noise front end in a receiver usually increases the amount of ignition noise received.

So the question "What is noise?" is actually much more than a rhetoric query; before we can begin to examine "noise" we must decide just which "noise" we're talking about.

When we want to know the meaning of a word, most of us consult a dictionary. That doesn't help us much this time. An ordinary dictionary provides the following:

"Noise. 1. A sound that is not musical or pleasant. 2. A sound. 3. Din of voices and movements; loud shouting; outcry; clamor."

None of these seem to fit any kind of "noise" we meet in radio. Let's try a physics textbook:

"Noise. An electrical signal having random distribution of frequency components and of amplitude, distributed throughout the electromagnetic spectrum from zero frequency to infinite frequency."

That's closer. Translated from the engineeringese, this is a precise definition of the kind of noise developed in a high-gain amplifier. That is, it's the hissing or frying sound which provides an absolute limit to useful gain.

But it doesn't even mention the effect of a passing dune-buggy on a 10-meter signal. To find a definition which will include that

kind of "noise," we must go to Information Theory:

"Noise. Any portion of a received signal which was not present in the transmitted signal."

That one, at first, seems to wrap it up with a definition which includes not only the sputtering ignition of passing autos, but atmospheric crashes and the physicist's kind of noise as well. This one, in fact, includes all interference of any sort as "noise."

But hold on there! This information-theory definition would even include qrm as "noise"—and while it would be nice, nobody expects any kind of noise limiter to get rid of interferring signals from other transmitters (though it would be worth while working out one which would do so, were it possible.)

So the common definition has little to do with radio, the physicists' definition is too narrow, and the information-theory definition is too broad. Can we ever answer our question, "What is noise?"

As it happens, we can. If we couldn't we wouldn't have asked it in the first place, naturally. What we must do is to break the broad term "noise" down into several more-limited categories, which we'll call "hiss," "sputter," and "crash" for our examination. Keep in mind, though, that these are only *our* names for them; the FCC will want other names which we'll dig out as we go.

Hiss is the physicists' kind of noise—random voltages which come out of a speaker as a hiss or frying sound. If you've ever turned a good amplifier all the way up with no input signal applied, you've probably heard hiss.

Sputter is ignition noise, electric-motor interference, and the like. Strictly speaking, these are "signals" rather than "noise," but they are so completely unlike the signals we expect to receive that the information-theory meaning of "noise" has come to apply. A graphic example of this is provided by radar pulse interference to uhf operators; the radar pulses are most definitely signals—but to the ham trying to dig through them, they're just so much noise and he has developed circuits to blank them out.

The final category, crash, is like sputter in many ways. The most common crash is the atmospheric static resulting from lightning strokes which wreaks havoc on 40 and 75 meters during the summer thunderstorm season.

The differences between hiss, sputter, and crash are easy to hear but difficult to describe. An oscilloscope display of the waveforms shows many of these differences. Figs. 1 through 3 are approximations of typical hiss, sputter, and crash waveforms respectively.

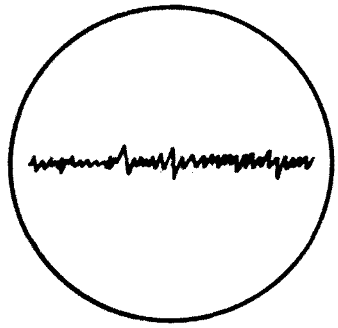


Fig. 1. Typical oscilloscope trace of "hiss," or random electrical noise due to thermal agitation. Origin of British term "grass" is obvious from waveform.

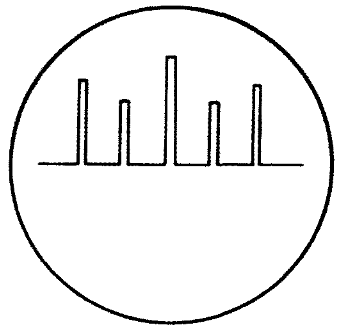


Fig. 2. Typical scope trace of "sputter," or impulse noise. This type of noise is distinguished by brevity of its pulses and usually regular recurrence rate. Most common source of sputter is by radiation from spark plugs in automobile ignition circuits, but it may originate elsewhere as well.

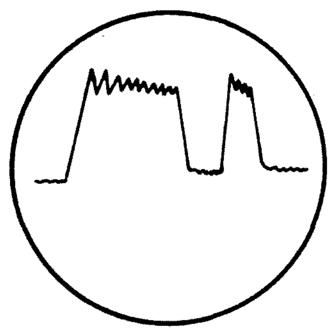


Fig. 3. "Crash," or atmospheric noise, presents waveforms such as this. Origin is spark discharge of lightning bolts; duration and magnitude of pulses are both larger than for sputter, and periodic repetition rate is absent.

While hiss is a relatively low-energy type of noise which is almost always present, sputter and crash are brief high-energy pulses. Sputter consists of shorter pulses which recur at a regular repitition rate, and crash is made up of longer pulses which occur only sporadically.

Some of the sources of hiss are "Johnson noise," "galactic noise," "shot noise," and "partition noise." In addition to these "official" names, hiss is also known as "grass" in industrial electronics where it plays a vital part. This unofficial name was adopted from British radar usage, and a look at Fig. 1 will show where the name came from originally.

"Johnson noise" is possibly the major source of hiss in any electronic circuit. This noise actually consists of the net effective movement of the electrons in any conductor or resistor. At any temperature greater than zero—which has never yet been attained—electrons are always in motion. This motion is unpredictable and so we call it "random." The random motion of the electrons in the circuit produces a small current, and if any resistance is present (as it always is) the current develops a voltage across it.

If any heat is applied to the conductor, its energy must go somewhere. It ends up for at least a time in the electrons of the conductor, where it makes them move more rapidly. This increase in motion increases the current flow, and so increases the Johnson noise.

Since the motion is completely unpredictable, it will contain frequency components all the way from the lowest frequencies imaginable to the highest, and with strengths (which depend upon the distance moved by each electron) over an equally wide range. The average strength is low, though, because the noise is spread over such a wide band.

The greater the bandwidth of a circuit, the more Johnson noise the circuit will amplify. This is one reason that the noise of an amplifier is affected by its bandwidth, and wideband amplifiers appear to be inherently more noisy.

Johnson noise is present in all conducting or resistive materials, and this includes the very thin plasma of ions which apparently pervades outer space. The resulting radiated noise which comes from outside our planet is usually called "galactic noise," however, to distinguish it from more mundane noise sources.

While Johnson noise is inherent in the nature of matter, and galactic noise is simply a form of Johnson noise originating outside our planet, shot noise and partition noise are connected with the way in which we amplify electrical signals. Although the terms originated in the days before transistors, similar effects are present in solid-state circuits and are often called by the same names.

Shot noise originates at the cathode of a tube and makes itself felt at the plate. You may recall that a tube operates by boiling electrons off the surface of the cathode and then controlling their flow to the plate circuit. Think back to the last pot you watched boil, and you'll remember that boiling is a rather violent and unpredictable action. At one instant many pockets of vapor may bubble up, and at the next instant none.

Electrons boil off the cathode surface in the same manner. While we know that in any easily measurable period of time a constant number of electrons will leave the cathode, we do *not* know just how many are going to leave in the next instant. They may wait a moment longer and then leave, or they may leave just a trifle sooner.

These random or unpredictable fluctuations in cathode emission effectively modulate the assumed steady flow, with variations which are electrically indistinguishable from Johnson noise.

We feel the effects only at the plate circuit, when the varying stream of electrons arrives. And, strangely enough, we usually attribute this noise to an imaginary resistance in series with the tube's grid, inside the tube, which we call the "equivalent noise resistance" of the tube, so that we can calculate the noise by the same equations used for Johnson noise.

Partition noise is similar in its origin to shot noise, and identical in its effects, but only afflicts multi-element tubes. Triodes are free of partition noise, and this is the major reason why triodes are preferred when extremely low noise must be attained in a circuit.

Partition noise comes about because any individual electron in the electron beam from cathode to plate *may* be captured by some other tube element such as the screen grid. We know that the screen will capture a certain proportion of the total number of the electrons flowing, to produce the screen current, but we cannot determine which or when.

This capture of random electrons amounts to a "partitioning" of the total cathode current between plate, screen, and any other positive elements inside the tube. Each electron partitioned out of the plate current never reaches the plate—and its absence produces a variation in the plate current which is called partition noise.

While shot noise is determined primarily by the design of any specific tube type, partition noise is determined by the operating voltages chosen by the circuit designer. The greater the current flowing through the screen

and similar elements, the greater the partition noise which will result.

Unlike these forms of hiss, the "noise" we are calling sputter is not inherent in the nature of our components and our circuits. It's really a form of undesired signal, radiated from its source and picked up by our receivers. Most noise-limiter circuits are intended to operate only on sputter.

The two most marked characteristics of sputter are the shortness of its pulses and the magnitude of its peak voltage. Most sputter, but not all, originates in the ignition circuits of internal-combustion engines, where it's radiated by the spark-plug wiring and spark gaps themselves.

The width of most sputter pulses ranges from one to 10 microseconds, which corresponds to a single cycle of a 2 mhz to 200 khz signal, respectively. This, as you can imagine, isn't very long. The repitition rate is determined by the speed at which the engine causing the sputter is running, but is usually relatively slow.

The only major difference between crash and sputter is that sputter, being caused by man-made sources, has less energy and lasts a shorter time. Additionally, while sputter recurs at a more or less regular rate, crash occurs only sporadically.

Since crash lasts longer, it's not as easy to get out of the signal. For this reason, most ANL circuits appear to be ineffective against crash although they usually perform at least acceptably against sputter. Actually, the circuits are performing the same function against either type of noise, but the crash remains objectionable after being limited while the briefer sputter is reduced to a livable level.

What does signal-to-noise ratio mean? We meet the phrase "signal-to-noise ratio," often abbreviated simply as "S/N," almost everywhere in electronics.

Information theory experts apply it to their studies, computer engineers study it in their digital communications networks—and radio operators curse it when the dx fades down into the mud.

In radio, we usually endow "signal-to-noise ratio" with a special restricted meaning, which is similar to but not identical with its meanings in other areas of electronics. When we use the phrase, we most usually mean specifically the ratio between the residual noise level of a receiver and the weakest signal that receiver can detect. It has nothing to do with sputter or crash, even though they may render a signal uncopiable. When used in this sense, signal-to-noise ratio is most often expressed in decibels, and we say for instance that the S/N ratio of a receiver in a given situation is +3 db.

In commercial broadcasting, a S/N ratio of +60 db is not uncommon, but most amateur signals (except for "armchair copy" situations) run in the range from +3 to +20 db. Any signal whose S/N ratio is less than +3 db is excessively difficult to copy although some experts can dig them out of the mud down to 0 db. Signals which are below the noise level, with a resulting S/N ratio less than 0 db, are literally buried and only sophisticated reception techniques can bring them out.

We saw earlier that hiss is equally distributed over the entire frequency spectrum. Among other things, this means that the wider the receiver's bandwidth the more hiss can be received; any single signal, on the other hand, has a limited bandwidth. If the receiver's bandwidth is wider than necessary to let the signal through, the signal level will not be affected but the level of hiss will be higher. The best S/N ratio for a given signal is obtained when the bandwidth is just wide enough to admit the signal. Then the least possible amount of hiss gets through to compete with the complete signal. For really weak signals, it often helps to cut bandwidth still more and lose some of the signal. This relationship between bandwidth and S/N ratio is one of the major advantages CW transmission enjoys in weak-signal work; the CW signal requires only a few cycles of bandwidth while any voice transmission requires much more, and the wider bandwidth lets more noise come through.

To specify the S/N ratio of a receiver, the signal itself must also be specified. A conventional method of measuring S/N ratio is to start with no signal input and measure the noise output, then introduce a slowly increasing signal level until the output power level doubles. This is the +3 db point, and the signal level which produced that condition is the minimum signal for which the receiver can produce a +3 db S/N ratio.

Another method of measuring is to introduce an arbitrary level of input signal—for instance, 1 microvolt—and determine the ratio of power output with signal to that without signal. In this case the result would be a specified S/N ratio for 1 microvolt input, while with the more conventional method the result would be a specified number of microvolts input for +3 db S/N ratio.

Measurements such as these are always

made under more or less ideal test conditions, but receivers in use are usually connected to an antenna in order to receive radio signals. Atmospheric and galactic noise offer additional sources of hiss to a receiver in use, which are not present under test conditions, and these additional hiss sources modify the usefulness of S/N ratio readings as comparisons of receiver quality.

If a receiver is capable of producing a +3 db S/N ratio with 1/10 microvolt input, and a second unit can produce the same S/N ratio with 1/100 microvolt while a third requires 10 microvolts to do as well, then it would seem obvious that the second receiver was 10 times as sensitive as the first while the third was 100 times less sensitive.

But if, in use, the antenna always furnished 20 microvolts of atmospheric and galactic noise, you wouldn't be able to tell the differences between the three receivers in your shack! Any one of the three would be better than necessary under such conditions.

On the other hand, if the noise level from the antenna never exceeded 1/1000 microvolt, the difference in sensitivity would be easy to tell in use since none of the units would reach the antenna noise.

The amount of "antenna noise," which includes all types of hiss and other noise coming in on the antenna lead-in, will naturally vary from location to location. It also varies from band to band. Man-made noise tends to predominate on the lower-frequency bands. Atmospheric and galactic noise provide the major part of antenna noise in the uhf regions and above.

When man-made noise provides a "floor," a receiver need not be excessively sensitive in order to reach that floor. For this reason the 5-tube ac-dc "All-American Five" works well on broadcast bands, and some near relatives of this simple receiver serve credibly on 40 and 75 meters. As frequency goes up, though, the sensitivity of the receiver must be progressively greater in order to be certain that you can detect any signal that's above the antenna noise, because the amount of antenna noise is going down as frequency increases.

By the time you get to the 10-meter band, S/N ratio of the receiver is important, and as you move into vhf operation it becomes ever more so. Low-noise receiver designs (which are actually low-hiss designs, to improve receiver sensitivity) predominate at vhf.

Fig. 4 is a graph of antenna noise versus frequency for two extremes of location; most situations will fall between these extremes. As you can see, for the lower bands S/N ratio of a receiver isn't something to worry about—but if your interest is in uhf, it's one of the most important items to be concerned with. Like most aspects of this fascinating activity of electronics, it all depends upon your viewpoint.

How is noise reduced? Noise reduction, as you must have surmised by now, offers not just one but several problems. The first is that of just which noise you're trying to reduce. Any measures to reduce hiss and consequently increase receiver sensitivity are most likely to increase sputter by making it more readily detectable.

Most noise limiters (including "blankers" and "silencers") are intended to reduce sputter, while most "low noise" circuitry is intended to reduce hiss. To cover our subject properly, we must examine both problems.

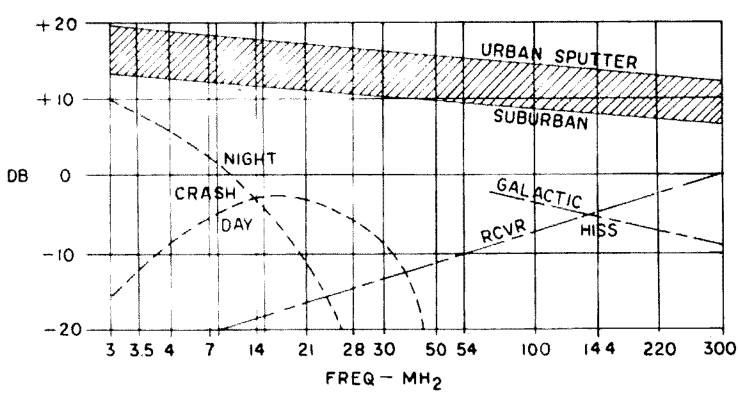


Fig. 4. Various sources of antenna noise and their average strength with respect to frequency are shown here. The 0-db point represents a field strength of 1 microvolt per meter; ham bands from 3 to 300 mhz are indicated on frequency scale. All curves are "median values," which mean that they will be exceeded as often as they will not be met. Receiver-noise curve, shown for comparison, is that of a typical tube-type receiver; exotic low-noise techniques are not considered.

Much of the material we'll explore in this section is presented in more detail in the *73* handbook, "Receivers" (plug), if you're interested in doing more with it than just learning the principles upon which it operates.

Let's look first at the circuitry intended to reduce hiss. This "low noise" area almost always involves the *rf* amplifier and/or mixer stages of a receiver, because any hiss that gets in in the early stages can't be taken out later.

Much has been written on the subject of noise (meaning hiss) in *rf* amplifiers, and you may be convinced already that for low hiss only triode tubes should be used. Don't believe it. A good transistor has lower noise than any tube, and a good pentode tube will out-perform a fair triode. In fact, a few pentodes are available which will out-perform almost all triodes—but they're expensive.

In general, though, when tubes are involved, triodes tend to have less noise because they're free of partition noise. They do, however, have less gain than pentodes, together with a tendency to oscillate unless neutralized.

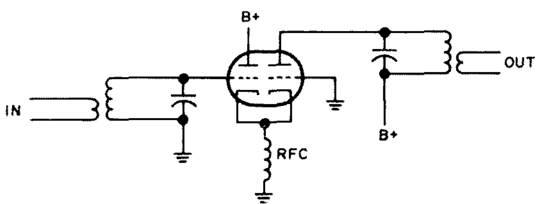


Fig. 5. Cathode-coupled amplifier schematic diagram.

A number of special low-noise circuits have been developed to overcome these disadvantages of triodes. Among them are the cathode-coupled amplifier **(Fig. 5)** and the cascode circuit **(Fig. 6)**. Both use two triode stages to provide the gain obtained by a single pentode, but twin-triode tubes were developed in the early years of TV to make such circuits competitive with pentode amplifiers.

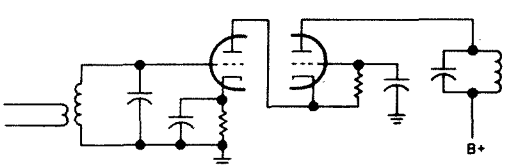


Fig. 6. Cascode amplifier schematic. This is series cascode circuit; the two tubes can also be shunt-connected but circuit is much more complex and performance is no better.

The cathode-coupled amplifier is essentially a grounded-grid amplifier, preceded by a cathode follower to match its low input impedance. The cathode follower has no voltage gain, and the grounded-grid has little

output-to-input feedback, so this circuit won't oscillate any more readily than would a pentode stage.

The cascode circuit is similar, with its grounded-grid output stage, but the input half is a conventional grounded-cathode stage rather than a cathode follower. The first stage is so loaded down by the grounded-grid's low input impedance that it cannot oscillate, even though it does have some voltage gain. The result is higher gain for the cascode than for the cathode-coupled, and equally low noise. Since its declassification in 1945, up until transistors came into wide use, the cascode was virtually the standard circuit for TV-receiver front ends, and became deservedly popular among vhf hams also.

Neutralized triode stages are also in wide use, as are plain grounded-grid circuits. The purpose of all of these approaches is to amplify weak signals to a level much greater than the Johnson noise of the rest of the receiver, while adding as little hiss of their own as possible. When receiver noise is an important factor, the first *rf* stage is the critical one; its noise level controls the noise level of the entire receiver.

The second receiver stage, though, is next most critical, and in many receiver designs this second stage is a mixer circuit. Mixers are inherently more noisy than are amplifiers for a number of reasons. One is that a mixer must combine two signals, and each of these signals has at least some noise in it. The output contains all the noise of both inputs.

In addition, the new signal created by the mixer is the difference between the two input signals, and at, at least one point in the mixing process, its strength is much less than that of either input signal. Thus the noise (which spreads across the entire spectrum) becomes a larger portion of the output signal.

Finally, in order to obtain mixing action of the type desired in a receiver the circuit must operate in a non-linear manner. The conditions which produce the desired non-linear operation also, in general, produce more noise.

Fortunately, it's possible to reduce noise in a mixer stage in several ways. One of the simplest—and it's so effective that it's still the standard technique in much uhf work—is to use a passive mixer rather than an active one; most often, a silicon diode is used as the mixer. This type of mixer does its work with the smallest noise contribution, but the output signal still contains noise from both the original input signals.

If gain is desired in the mixer stage, and it most usually is, then a low-noise mixer circuit can be used. Fig. 7 shows one twin-triode mixer which has as little mixer noise as any vacuum-tube circuit available; the resemblance to a cathode-coupled amplifier is obvious and the only major difference is that the second input is applied to the grid which is grounded in the amplifier circuit. Since the output circuit is not tuned to the same frequency as either input there is little tendency to oscillate and screening action is not so necessary.

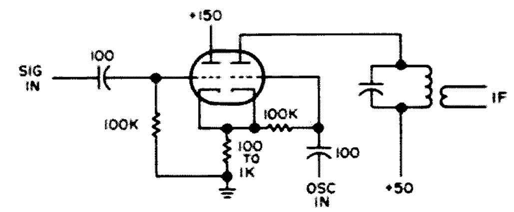


Fig. 7. Low-noise twin-triode mixer circuit first popularized through article in October, 1961, issue of 73. Circuit was taken from design by K. A. Pullen. Noise is as low as that of cathode-coupled amplifier which this circuit resembles.

The ultimate limit to which hiss can be reduced in a receiver is reached when the antenna noise produces a noticeable increase in total noise output, but it *is* possible in some cases to reduce noise of the receiving system still more.

If antenna noise is setting the floor for signal reception, and an omnidirectional antenna is in use, there's a chance that some of the antenna noise is coming from a different direction than is the signal. Use of a directional antenna will then cut down on the noise picked up by the antenna, and may thus reduce antenna noise.

If the reduced level of antenna noise is still setting the limit for weak-signal reception nothing will be changed. However, it's possible—and frequently turns out—that the reduced antenna noise is once again lower in level than internal receiver noise; in such a case, additional improvement in receiver sensitivity will pay off.

How about reducing sputter? A look back at **Fig. 2** will show that sputter is characterized by high-intensity, sharply rising pulses of energy. Most of the time they're absent, but when one hits a receiver's circuits the result is chaos for the duration of the sputter pulse.

The high-energy pulse causes *if* transformers to "ring," overloads amplifier circuits, charges up the avc circuits to reduce receiver

sensitivity, and after doing all this comes out as an ear-shattering smash of sound.

If each of the pulses could be limited in strength to a level no greater than that of the strongest component in the received signal, things would be much better. You would still hear the sputter, but it wouldn't blanket the signal out completely because the signal is there most of the time and the sputter is present only a small part of the time.

As their name implies, most noise limiter circuits have exactly this purpose: to *limit* the incoming signal level. An automatic noise limiter adjusts its limiting level automatically to that of the signal; any sputter pulse which exceeds this level is trimmed off or limited at its top.

If, though, instead of merely limiting the pulses, we could make the receiver completely dead until the pulse disappears, then we would blank out everything for the duration of the sputter pulse. We would have "holes" in our signal, but they would be quite short, and would be holes of silence rather than of noise.

That's the way a noise blanker works. It doesn't kill the entire receiver, but it blanks the output at some early stage whenever a sputter pulse is present, and lets through only the signal.

While the noise in the audio output is bothersome, it's only a small part of the damage sputter does to the receiving process. The ringing of circuits all through the receiver makes the pulse appear to last much longer than it actually does, and the reduction of sensitivity can make it impossible to detect signals of quite respectable strength. A noise limiter removes only a part of the problem, since it usually operates only upon the recovered audio. A blanker, on the other hand, is usually placed at the earliest stage in the receiver at which adequate signal level is available, and thus takes out most of the problem.

Most often, the blanker is placed between the mixer stage and the *if* amplifier. Noise may get as far as through the mixer, but no farther.

Many different types of limiter and blanker circuits exist; they are far too numerous to examine in detail here. The *73* "Receivers" handbook includes diagrams of many.

Crash has much the same waveform as sputter, but the pulses are longer and frequently are more powerful as well. This difference in duration and strength is just enough to make a limiter or blanker circuit which works well against sputter appear to be inef-

fective against crash.

The problem is that while limited sputter can be tolerated by most ears, a crash pulse limited to the same level will appear to be much louder because it lasts so much longer. Meanwhile, its greater strength ahead of the limiter has overloaded circuits and caused improper operation of most of the rest of the receiver.

Similarly, our ears tend to fill in the brief periods of silence which result when a blanker takes out sputter pulses, but the pulses of crash last long enough to be bothersome.

In general, blanker circuits tend to outperform limiters against both sputter and crash–and offer almost the only usable defense against severe crash problems. Fortunately, crash is the smallest of the three noise problems since it is objectionable only when thunderstorms are within radio range of the receiver.

How are signals detected? While three major types of modulations systems are in commercial use, only two of these are used to any appreciable extent by amateurs. The two we use are known to engineers as amplitude modulation (which includes CW and SSB) and angle modulation (which is composed of FM and phase modulation both); the third, pulse modulation, is illegal except at uhf.

Each of the major types of modulation systems produces signals of differing types, and each type of signal must be detected differently.

However, the obvious differences between the different types of detectors tends to mask some less-obvious similarities of the two modulation systems we use, so before we begin to look at the detection schemes themselves let's take a second look at the modulation systems.

All ham modulation systems carry the information in sidebands which accompany the carrier. Even CW has its sidebands, which provide the "keying characteristic" of the signal. The only real difference between the amplitude modulation system and the angle modulation system lies in the relative phasing between sidebands and carrier.

In any amplitude modulation system, the phase relationships between the sidebands and the carrier are such that the "envelope" of the total signal–that is, the total amount of energy present at any instant within the signal's bandwidth–appears to vary at a rate determined by the modulating signal. In this system, the carrier level actually remains constant; the fluctuations in the sideband levels cause the apparent variations in the envelope.

In any angle modulation system, the phase relationships between the sidebands and the carrier are such that the envelope appears to remain constant, but the apparent frequency of the carrier signal varies at the modulating rate. Actually, the frequencies remain the same but the carrier level fluctuates at the same rate as the sidebands. This, together with the phase-aiding or cancellation effects, gives the appearance of constant level and varying frequency.

If you consider the sidebands as the reference, the difference between amplitude and angle modulation amounts to a 90 degree difference in carrier phase; that's all it takes to change one system to the other. At least one detector circuit has been designed on just this principle.

Now that we've seen the similarities between the two general systems, and the small but critical difference between them, let's turn our attention to the amplitude modulation family and look a little closer at its various members. After all, they make up most ham applications.

Within the amplitude modulation family, we can take our choice of CW, double sideband full carrier (what we usually call AM), double sideband suppressed carrier (DSB), or single sideband suppressed carrier (SSB). There are other possibilities also, but these four are the ones most commonly met.

Since all four are members of the amplitude modulation family, they have the characteristic of apparently constant carrier frequency and varying signal envelope level. The CW envelope varies between the two extremes of zero and full-signal while the other three vary at an audio rate with many in-between levels.

We can see the varying envelope if we examine an AM signal with a good oscilloscope; if we rectify this signal the resulting dc output of the rectifier will still vary just as the signal envelope did, provided only that we do not filter out the variations. This is a valid technique for detection of conventional AM, and detector circuits based on this principle are known as "envelope detectors." **Fig. 8** shows a popular envelope detector circuit in comparison with a half-wave rectifier power supply circuit.

However, the envelope variations follow the original modulation only because of the phase relationship between sidebands and the original carrier. If the original carrier is re-

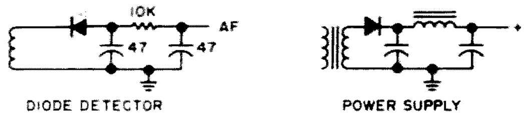


Fig. 8. Diode envelope detector compared to half-wave power supply circuit. Major difference is that power supply uses choke for more complete filtering—but detector is intended to preserve audio and filter out only *rf* half-cycles.

moved before transmission, as in SSB or DSB, the envelope variations cannot reflect the original audio and the result is a meaningless signal when envelope detection is used.

And, a CW signal, if envelope detected, will produce only a pulsating dc output which our ears cannot hear. It's possible to use the dc output of an envelope detector to key an audio oscillator, or to drive a pen recorder—but we cannot feed it directly to phones or a speaker.

The envelope detector of Fig. 8, then, is fine for conventional AM but by itself is of little value in detecting CW, DSB, or SSB signals.

Pioneers in the art of radio early realized that one way to make the CW signal and the envelope detector get along with each other was to introduce a new signal from a beat-frequency oscillator; the envelope detector would then *mix* the incoming CW signal and the locally-supplied BFO signal to produce an audio output.

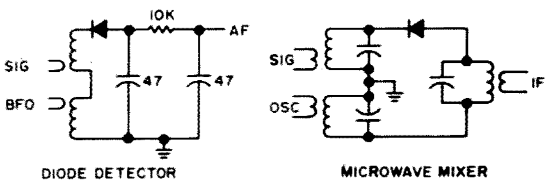


Fig. 9. Diode envelope detector compared to microwave crystal mixer circuit. In practice, diode uses only one transformer at input but signal and BFO frequencies are both fed into it. Major difference here, as in Fig. 8, is in output circuit. Diode action is similar.

It wasn't until much later, though, that they realized that the envelope detector, which looks so much like a half-wave rectifier, actually is acting as a mixer all the time! When it's receiving AM, it's mixing the carrier of the signal with the sidebands and producing as a difference-frequency output the modulating audio signal. When receiving CW with a BFO, it's mixing the CW and BFO signals to produce an on-or-off audio tone.

Fig. 9 compares the same envelope detector shown in Fig. 8 to a microwave-style crystal mixer circuit. Again the similarities are obvious.

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In a mixer, the ratio between the two input signals is rather critical for best results—and receiving CW using an envelope detector also calls for critical adjustments of signal level to BFO level.

Until the rise of SSB, the envelope detector was the standard detector circuit in communications receivers. But when SSB came into use, the critical adjustments quickly became unpopular.

It's possible to receive SSB using an envelope detector, just the same way as CW is received. The signal level must be carefully adjusted by using the receiver's *rf* gain control, and the BFO must be tuned to one edge of the *if* passband. Then the signal is carefully tuned to a point where the BFO signal precisely fits into the place left by the suppressed original carrier. At this point, the BFO is supplying a local carrier and the sidebands are at the proper level with respect to it; the result is instant audio, and in many cases you cannot tell the sound from AM.

But if the signal level changes because of fading—and particularly if it increases—distortion may get into the act. In addition, you will hear annoying chatter from other signals which are not at the same frequency but are near enough to produce some sound output.

And the procedure takes a considerable amount of care. When this technique is used to receive SSB, you usually keep both hands on the receiver controls most of the time.

So other detector circuits were devised, based upon the same principles as the mixer circuits used in the front end of the receiver. These circuits are known collectively as "product detectors;" a couple of them are shown in **Fig. 10**.

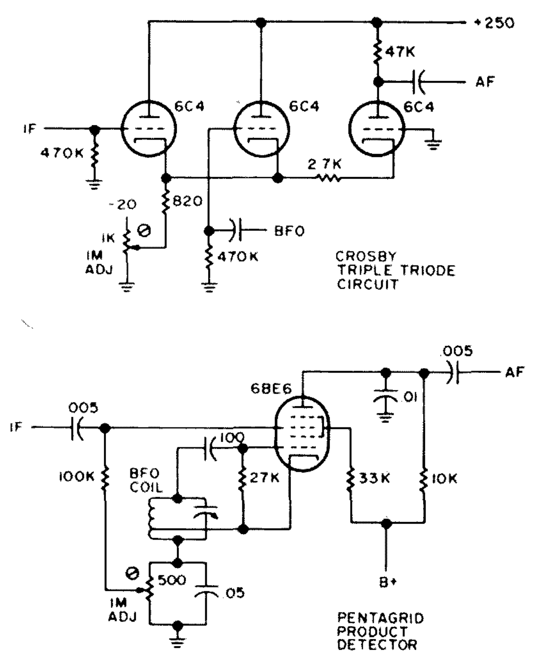


Fig. 10. Two product-detector circuits. Similarity of these to conventional *rf* mixer circuits can be seen; major difference is inclusion of "IM ADJ" control for each, to adjust operating conditions for minimum intermodulation in detected signal.

In any product detector, the circuit is set up so that signals coming in at the same input port cannot mix with each other. Mixing only occurs between the signals coming in at the two different input ports. One of these ports gets its signal from the BFO and the other gets the signals from the *if* strip. The result is lower distortion since *if* signals cannot mix with each other as they do in an envelope detector. Additionally, the circuit is usually designed to permit a much wider range of signal levels, so that fewer operating adjustments are required.

Because a product detector is designed to prohibit mixing between any two signals coming in at the same input port, it cannot produce output unless signals are present at both inputs. This is the major point which can be used to distinguish between product and envelope detectors; a product detector produces output only when the BFO is turned on, while an envelope detector produces output whenever it has any input signal whether the BFO is on or off.

Today's receivers usually include two detector circuits, one of each type, and switch from one to the other depending upon the type of signal to be received. Since CW reception also requires mixing to produce audio output, the product detector is used for it as well as for SSB and the envelope detector is used for AM.

Reception of DSB is a bit more of a problem, since it has both sidebands present. In this case, the local carrier must be not only exactly on frequency with the original carrier, but must also be locked to it in phase; it only takes a 90 degree phase difference to turn the signal from DSB into FM or PM!

One solution to the problem is the use of a "synchronous detector," but a more common way out is to use the receiver's inherent selectivity to shave off one of the sidebands and then treat the signal the same way as an SSB signal. The only advantage DSB has, when this is done, is that the receiving operator has the choice of which sideband to use.

If one is clobbered by interference, he can use the other.

How does FM reception differ from AM? Now that we've examined the two major ways of receiving amplitude modulated signals, let's turn our attention to the other modulation system—angle modulation. This system is composed of frequency (FM) and phase (PM) modulation; both are detected in the same way and the only effective difference between them is in their audio response curves. By suitable tailoring of audio frequency-response curves, either can be converted into the other.

We have seen that the traditional techniques for detection of AM operate upon the apparent variation of signal envelope level; similarly, the normal techniques for detection of FM operate upon the apparent variation of signal frequency.

One of the oldest such detector circuits is the Foster-Seeley discriminator, sometimes called a phase discriminator or merely a discriminator. It's shown in Fig. 11. As you can see, this circuit consists of two AM envelope detectors tied back-to-back, fed by a rather unusual transformer. This transformer is the secret of the circuit.

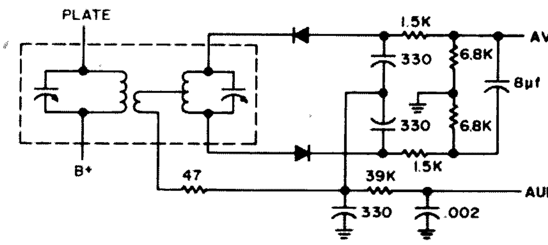


Fig. 11. FM discriminator schematic. Action depends upon design and adjustment of special transformer, shown in dotted box.

In any transformer tuned to resonance, there's a 90 degree phase shift between the primary and secondary voltages. In the discriminator, a part of the primary voltage is coupled into the secondary at the tap, and also into the detector output at the junction of the resistors.

Each of the two diodes produces its own output voltage across its own load resistor—but the phase relationships are such that the *total* voltage developed across the two resistors in series is actually the *difference* in output between the two diodes.

If both are producing the same output voltage, as they will when the incoming signal is at the exact resonance frequency of the transformer, the difference will be zero.

If the frequency of the incoming signal is slightly higher than that at which the trans-

former is resonant, the output of the upper diode will be greater than that of the lower, and the output will be a positive voltage.

If, on the other hand, the incoming signal is at a lower frequency than the center-frequency at which the transformer is resonant, the output of the lower diode will be greater and the total output will be a negative voltage.

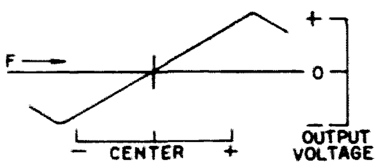


Fig. 12. Response of discriminator as frequency is varied above and below "center frequency" for which circuit is adjusted. Output swings either positive or negative depending upon direction of frequency swing.

As the frequency of the incoming signal is varied around the center frequency for the circuit, output voltage will follow the S-shaped curve shown in **Fig. 12**. So long as the frequency variations are limited to the straight part of this curve, they will be translated linearly to output voltage variations.

This circuit, while most effective at converting frequency variations into voltage variations, is also sensitive to voltage variations at its input. A stronger signal at the input will produce stronger signal at the output; in other words, it will receive AM as well as FM.

And one of the major advantages of FM over AM is that most sputter and crash is AM; it's possible to make an FM receiver that won't receive AM, and thus get rid of much troublesome noise.

To do this with a discriminator, it's necessary to put one or more "limiter" stages in the *if* strip ahead of the discriminator. These limiter stages serve to strip off all amplitude variations from the incoming signal, leaving only the frequency variations. The discriminator then detects the frequency variations.

The circuit most often used for limiting is simply an overdriven amplifier stage, sometimes with a grid resistor to increase its effectiveness as a limiter. Enough gain is provided ahead of the limiter to assure that it is overdriven at all times, even by the hiss normally coming in from the antenna.

To get away from the need for a limiter, several other FM detector circuits have been developed. One of the most popular is known as the ratio detector. It resembles the discriminator to some degree, as you can see from **Fig. 13**.

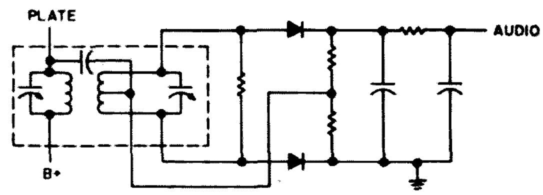


Fig. 13. FM ratio detector schematic. Like the discriminator, this requires a special transformer (shown dotted) but of a different type than the discriminator. Audio output of this circuit also swings either positive or negative, but an additional always-negative voltage dependent upon signal strength, which may be used for avc, is also available.

The major differences between the ratio detector and the discriminator are that one diode is reversed, in the ratio detector, and that a large capacitor is placed across the series-connected load resistors to filter off any amplitude variations. The audio output is then taken from the center-tap rather than across the resistors.

Reversing the diode changes the effective phase relationships so that the output voltage is now determined by the ratio between individual diode outputs, rather than by the difference. If an AM signal is received, the ratio remains relatively constant; only a signal with a varying frequency component can change the ratio and thus produce output audio.

Not all FM detectors use the two-diode techniques. One of the first to get away from such principles entirely was the Bradley locked-oscillator circuit. In this circuit, a rather unstable local oscillator, designed to produce an output vbltage which varied with the frequency at which the oscillator was running, was synchronized or "locked" to the incoming signal. The output of the oscillator then varied with the frequency of the incoming signal.

A similar principle more recently used is the gated-beam discriminator, which required a special type of tube design. This tube was capable of oscillating with one set of elements, while being turned on or off by a second set. The input signal was used to turn the tube on and off in step with the incoming signal frequency while the free-running oscillator also caused an on-off action. The result was that the tube's plate current consisted of a series of pulses, the width of which was determined by the ratio between incoming signal frequency and the "quadrature circuit" frequency associated with the tube. These pulses, filtered, produced the audio

output.

This circuit, using the 6BN6 or similar tubes, was almost standard for TV audio reception for many years. It is not, however, convenient for use with transistors, and the ratio detector and discriminator are still holding their own as a result.

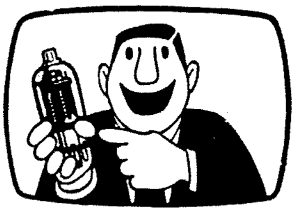
The final technique for detection of FM is one which also can be used for AM; in fact, it's almost a "universal detector." The circuit has been around since 1957, but is still virtually unknown because of its complexity. It's known as "synchronous detection."

We don't have space here to go into it in detail; essentially it makes use of the fact that the sidebands themselves contain all necessary phase information, and also of the fact that a 90 degree phase shift between carrier and sidebands converts AM to FM/PM. Any incoming signal is split into two parts and applied to a pair of balanced mixers. The other input to these mixers is the local oscillator signal; it's shifted 90 degrees before application to one and applied directly to the other. Outputs of the two mixers, then, result from AM on one side and PM on the other, regardless of the original signal type. These two output signals are fed to a phase detector, which produces a dc control voltage. The control voltage then varies the frequency of the local oscillator. The idea is to keep the local oscillator locked to a frequency which will produce maximum output from one of the balanced mixers and zero output from the other.

If the incoming signal is FM or PM, the 90 degree phase shift in the synchronous detector converts it back to AM. If it's AM, the local oscillator is locked into phase synchronization with the carrier and there's no bothersome beat note. If it's DSB, the same conditions hold, and perfect reception results. For SSB, no locking action occurs but the balanced mixers act as product detectors. And as an additional bonus, any interference which is present in only one sideband of any received signal cancels itself out in the output of the circuit.

Circuits of this sort are now standard in aerospace communications, but for amateur use the complexity is still frightening to most of us. For instance, the first such circuit published for ham construction required 11 extra tubes, plus phase-shift networks and power supply.

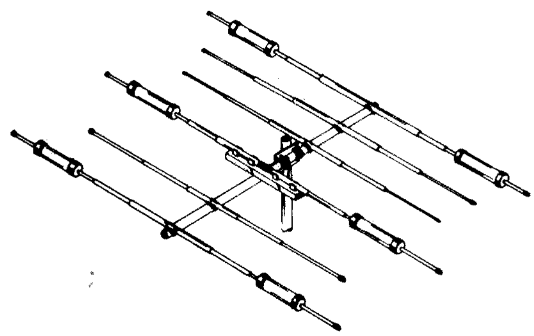
Next Month. We'll continue our examination of receiver techniques.



NEW PRODUCTS

Mosley Tri-Bander

The Mosley CL-36 is a three band (10-15-20) six element beam. The gain on this monster is rated at 9db on 10M, and 8db on 15 and 20M. That's good! This is the famous old Mosley TA-36 beam with their new balanced capacitive feed system, which resists corrosion much better than the older types. Weighs 69 pounds and costs under $175. It will handle maximum power on all three bands.

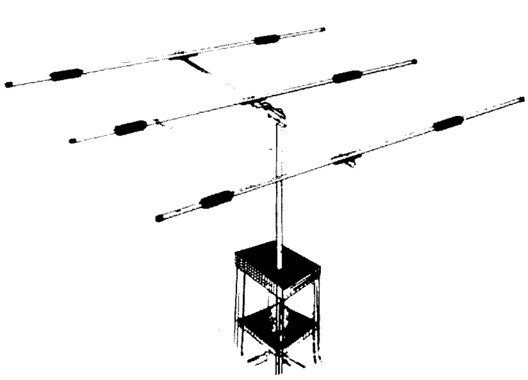


Code on Tape

Epsilon Records has just announced that they will henceforth have their code practice course available not only on good old 33 type records, but also on the newfangled tape cassettes. It is getting so that darned few hamshacks are recorderless, and the new cassette type tape recorders are really getting around. Score one for Epsilon and their new cassette code course.

Mosley Mini-Beams

Since it is the current section of the antenna that does the radiating, the question is frequently raised, "Why not shorten the voltage end of the antenna and save some space." The answer is, "Why not?" And this is just what Mosley has done with their new 10 and 15 meter Mini-Beams. The 10M (MB-10) is about 11' long instead of 16', thereby cutting off five not very useful feet of weight and wind load. The gain is advertised as 7.5 db, just a bit under the gain of a full sized beam. The five lost feet is made up with loading coils. The whole beam weighs in at six pounds, plenty light for even a small TV rotator. Costs under $45. The MB-15 is under eight pounds and costs under $45!



Reviewing the DAH-DITTER Model EK-1 Electronic Keyer

The M&M Electronics EK-1 Keyer is a real joy for the CW operator. It is self completing, so that neither dots nor dashes can be cut short, and it provides exact three to one dah to dit ratio with correct spacing between characters.

It can be used with any key providing SPDT action with center off. I used it both with the James Permaflex Key and with my antique Vibroplex bug. When used with the "bug" type key, it is necessary to disable the spring mechanism on the dit side. This is easily accomplished by using a rubber band to tie the end of the vibrating arm to the right side of the damper at the rear of the base, and adjusting the contact settings for correct contact spacing.

A built-in side tone monitor provides a constant tone without using the station receiver. Reed relay output makes it possible to use either grid block keying or cathode keying by following simple instructions.

The Dah-Ditter is adjustable from about 5-40 wpm with a single control, and allows an operator to send perfect CW with a minimum of practice. However, even though the keyer will space automatically between dits and dahs in a single letter, it is still up to the operator to provide correct spacing between letters and words. A few hours of prac-

tice should be sufficient for anyone who has used a keyer in the past.

This keyer uses modern digital computer techniques utilizing digital flip flops and gates which are arranged to give correct spacing independent of speed setting. It is not necessary to make adjustments for each speed setting.

The instructions supplied with the Dah-Ditter are complete and explicit. Complete circuitry is provided in the event trouble-shooting is needed. The unit is fully guaranteed for ninety days under standard warranty terms, but if trouble develops outside the warranty terms, it may be returned for factory service for a nominal charge of $7.50. This charge does not cover cockpit troubles where the equipment has been abused, however. Under normal use and installation, the IC's used should give thousands of hours of reliable service.

Considering the modest price of $34.95, this keyer is a good deal. Further information is available from M&M Electronics, 6835 Sunnybrook, N.E., Atlanta, Georgia 30328.

...W1EMV

Make Your Soldering Gun Tip Last Longer

My soldering gun tip always seemed to part company near the end of a project when I least wanted to stop everything to change it. The natural result was an attempt to finish the job with the two ends bent together or by completing the circuit through the joint to be soldered. Neither of these methods has been found conducive to good workmanship.

While not eliminating the problem entirely, the following will increase tip life considerably and make these frustrating moments fewer and further between.

Obtain (your refrigeration repairman is the best bet) a short piece of silver solder and a small quantity of flux. Sand the tip until it is bright and completely free of oxides. A stiff wire brush will do as well. Dip the tip in flux and apply the heat of a household-type propane torch to a point slightly below the tip proper. When the flux starts to look glassy, gently touch the silver solder to the tip until it starts to melt. The solder will shortly flow over the tip forming a protective coating. You may need to add a little more solder to insure that the whole tip is covered. When cool, brush the tip and tin as usual. The silver solder prevents the oxidation which causes the tip to erode and makes it last several times longer.

William P. Turner, WAØABI

Clifford Klinert, WB6BIH
520 Division Street
National City, California 92050

A Stable HF VFO

This article will describe a transistorized vfo to cover the amateur high frequency bands from 3.5 to 30 mhz. It is designed to drive small transmitters such as the DX-40, which have provisions for vfo input and 115 vac output for a *tr* switch. Construction details and sources for obtaining parts are given to aid the home-brewers.

Circuit Details

Fig. 1 shows the oscillator circuit. This is a Seiler oscillator using the popular MPF-102. This transistor has a minimum effect on the frequency of the tuned circuit. The tuned circuit, however, will change frequency with temperature. In breadboarding experiments with this circuit, soldering really caused frustration. If the temperature of the shack in the morning was about 50 degrees, after turning on the heater and the oscillator, the frequency would gradually drift as the room changed temperature. In a later test, when the temperature was constant, the stability was much better. In this test, the vfo was zero-beated with a crystal oscillator. A rather unusual behavior resulted. The beat note would rise to about three or four Hertz over a five minute period, and then go back thru zero beat. The drift was never more than a few Hertz, and went back and forth in this manner over a one hour test period. Of course, this could have been caused by several things, but it illustrated the stability of the oscillator.

The only possible cause of trouble in the oscillator is in the small capacitor in series between the gate of the MPF-102 and the tuned circuit. If this capacitor is too small the oscillator will not oscillate. For best performance the capacitor should be just large

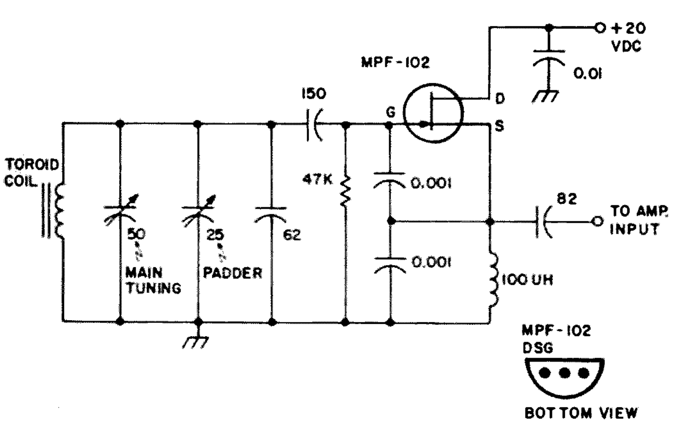


Fig. 1. Oscillator schematic. All capacitors are mica except variables and .01 disc ceramic. The toroid coil is described in the text.

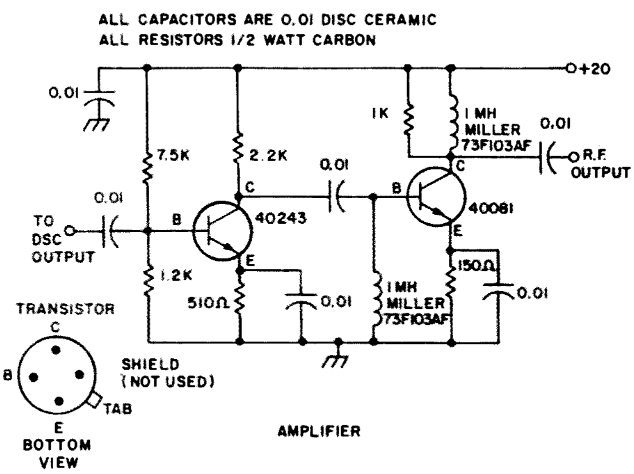


Fig. 2. Amplifier schematic. All capacitors are .01 microfarad disc. Resistors are half watt carbon.

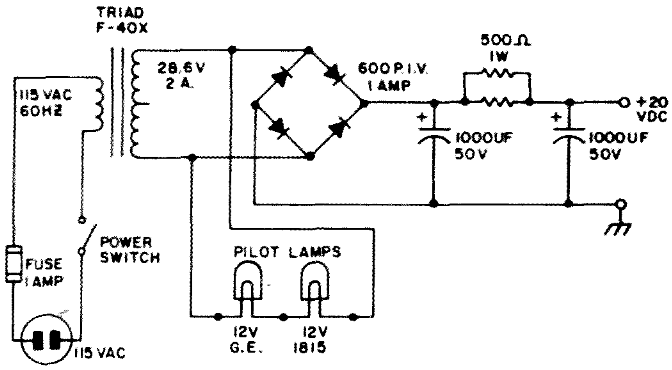


Fig. 3. Power supply.

enough to maintain stable oscillation. The 150 pf value has been found to be adequate for most circuits.

The amplifier circuit is shown in **Fig. 2.** This is a simple two stage common-emitter amplifier. The 40243 is biased into class A to act as a buffer. The quiescent collector current is about four or five milliamperes. This rather high value of current was chosen to allow a high output signal voltage. This high collector current also reduces the input impedance to as low as five hundred ohms. Performance was adequate, however, and the circuit was left as it was. The main advantage of this design is bias stability. Almost any vhf or hf silicon NPN transistor can be plugged into this circuit in place of the 40243. The low value of the base resistors allows for variations in h_{fe} of the transistor. The emitter resistor voltage drop of about two volts helps to compensate for changes in the base-emitter voltage drop of the transistor. The 40243 is a small signal transistor used for FM receiver applications and was selected because of its low cost and availability.

The 40081 output stage is pushed into class C by the 150 ohm emitter resistor. *RF* chokes are used instead of tuned circuits to

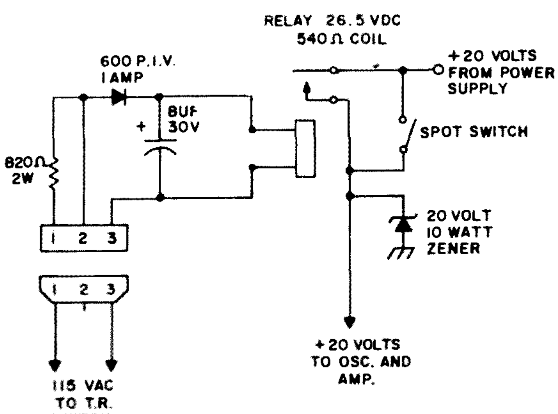


Fig. 4. Control switching.

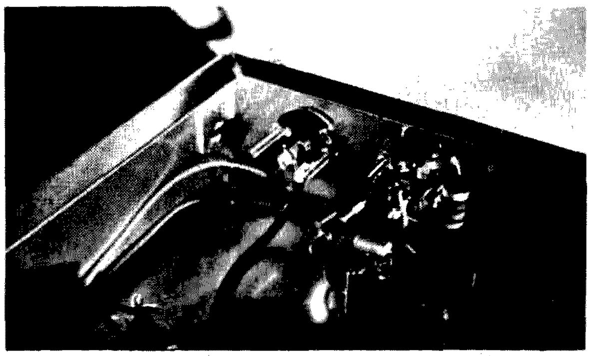
Fig. 5. A list of parts obtained from Allied catalog.

Part	**Stock Number**
Dial	47F3241
Cabinet	42-7200
Chassis	42F7851
Chassis	42F7904
P.C. Board	47F0592
Tuning Capacitor	43F3663
Transformer	54F4974

P.C. boards can be had from Spicer, 11 Ridgeland Road, Wallingford, CT 06492.

provide a broad banded output. The 1 K resistor in the collector of the 40081 reduces the Q to prevent parasitic oscillations. The output voltage is about ten volts peak-to-peak, and provides adequate drive on all bands when used with a DX-40 transmitter.

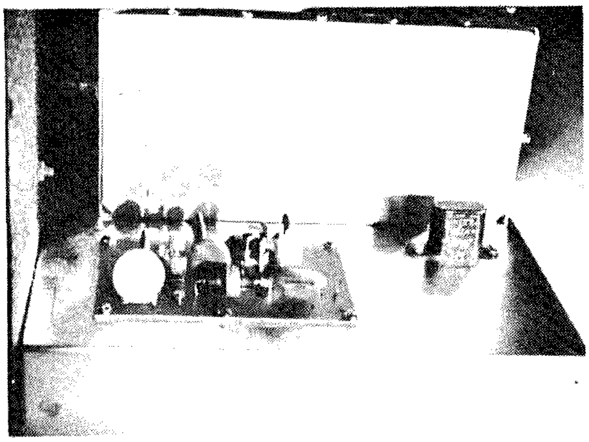
The power supply in **Fig. 3** is very conventional in design. The resistance between the two filter capacitors drops the almost 40 volt peak output from the bridge rectifier to 20 volts across the Zener voltage regulator diode. The total resistance could be increased to almost 1 K before the voltage would drop, but high current is maintained for stability.



Control circuit and output jack.

The control circuit of **Fig. 4** is used to turn the vfo on when 115 vac is applied from the transmitter TR relay. A "spot" switch is also provided to manually activate the vfo. Almost any relay that can be activated by 115 vac could be used. The one I used was surplus. If a dc relay is used, first calculate the coil current from its voltage and resistance. The rectified dc voltage is about 70 volts. 70 volts minus the coil voltage is the voltage drop required of the resistors of **Fig. 4.** Its value is found by dividing the voltage drop by the coil current.

The Zener diode is also shown in **Fig. 4.** It is only in use when the vfo is activated. This is done to reduce heating from the diode and dropping resistors.



Amplifier board mounted on chassis. Relay is at right.

Construction

As a convenience, some of the major parts were obtained from Allied Radio. **Fig. 5** lists them with their stock numbers. Other parts will be described as completely as possible. The pictures will also aid in describing the mechanical layout.

The first step is to mount the dial with the instructions and template supplied by the manufacturer. The dial is centered on the front panel. The chassis is mounted, being careful to allow for the flange on the front of the cabinet. The smaller chassis is mounted in the center of the larger one after the hole for the tuning capacitor is measured and drilled. No special attempts were made to make the structure more rigid. The method used is simple and the structure is remarkably stiff.

The fabrication of the printed circuit boards will be discussed in one step because of their similarity, but a definite order should be observed to simplify construction. The power supply should be attempted first because it is the easiest and will be needed to test the other circuits.

Fig. 6 shows the general layout of the printed circuit board for the power supply. As with the other boards, the actual parts to be used should be checked for fit before laying out the board. The method used in making these boards is a result of personal preference, and other builders may have their own methods.

The first step was laying out all the parts on a piece of paper corresponding to the layout of the schematic. The mounting holes were measured and marked, carefully checking with the actual parts. Then lines were used to connect components as in the schematic. The paper was then cut out and taped to the unetched copper side of the circuit board. Holes were drilled for components using the paper as a template. With the paper removed and the copper cleaned with steel wool, the holes are connected with the resist material. A type of acid-resistant lacquer was used for the resist in this case. However, almost any kind of good enamel paint could be used. Dry-transfer kits are available which will make a much neater job, but with the paint you have lower cost (free in this case) and more "freedom of expression" in making wider conductors. As much of the copper was covered as was possible. This was done to provide a handier low impedance ground around the edge of the board. This also makes it possible to use less etchant which is much more expensive than the resist. The etchant used was a commercially available brand packaged in small amounts. A one-gallon bottle of Ferric Chloride ($FeCl_2$) solution was also obtained from a chemical supply house for about three dollars. Either etchant gave good results, but it is important to keep the etchant solution warm while etching.

After the board has etched sufficiently, wash it with water to remove the acid, and in

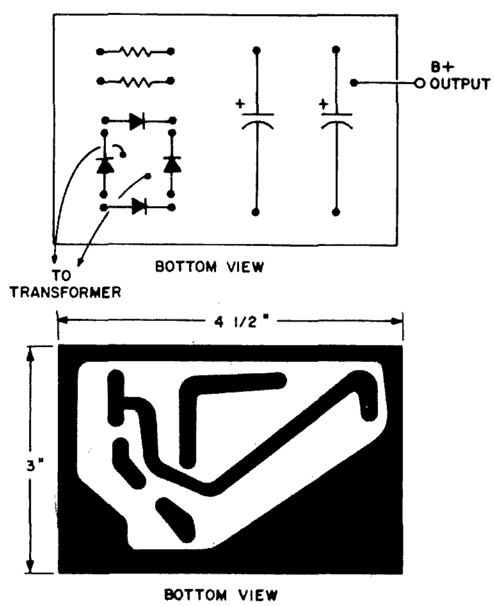
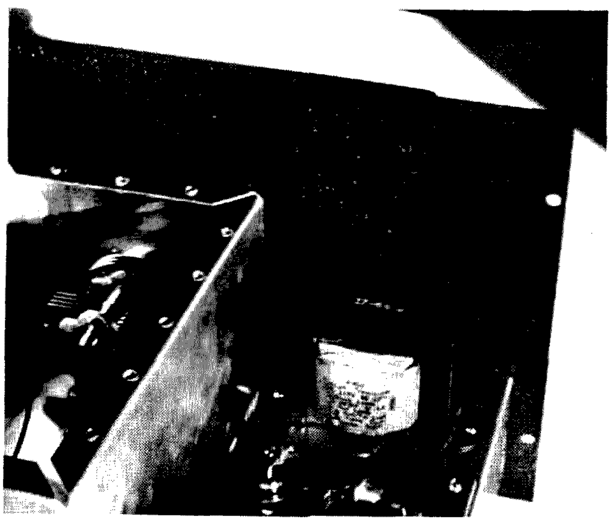


Fig. 6. Power supply board layout. Both board and component location illustrations are full size and bottom views.

paint thinner to remove the resist. You might wish to use steel wool once again to clean the copper before soldering. It will take only a few minutes to place the components, solder them in, and clip excess leads.

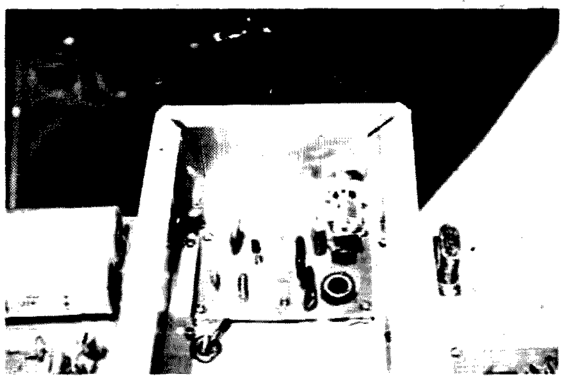
Since there was no need for miniaturization, the boards were made large to make assembly easier. Some builders may prefer to avoid using printed circuit boards, but they present a very neat appearance and reduce errors. If the board layout is copied properly, it serves as a check against errors in the schematic that can be made by either the author, draftsman, or reader.

With the power supply board completed, temporarily connect the transformer. The voltage without the Zener diode should be about thirty-five to forty volts. The Zener diode is stud-mounted to the chassis to provide heat dissipation. After the diode is added, the output voltage should drop to about twenty volts or slightly higher. The diodes in this case were "surplus" diodes obtained from Solid State Sales at a reasonable price. Delivery will usually take less than a week after mailing the order, even to the west coast.



Power transformer and tuning capacitor mounting.

After the power supply has been checked out and is working properly it can be mounted on the chassis. A hole is cut in the chassis with a nibbler, and the board is bolted in place. This is a good time to complete wiring connected with the ac switch, line cord, fuse and pilot lamps. Put some electrical tape on the inside of the metal dial front cover. With the pilot lamps wired in series, the metal cover will short them out. Tie points are used liberally under the chassis to make the wiring neater.



A look inside the oscillator box.

Fig. 7 shows the board layout for the oscillator. The method is the same as that for the power supply except for mounting. Since the oscillator is shielded (for temperature, not *rf*) it must be completely inside its box. Spacers are used to lift the board from the chassis to prevent shorting. The toroid coil is mounted on the board with glue. The form is available from Amidon Associates, 12033 Otsego Street, North Hollywood, California 91607. Thirty-eight turns of number 30 wire

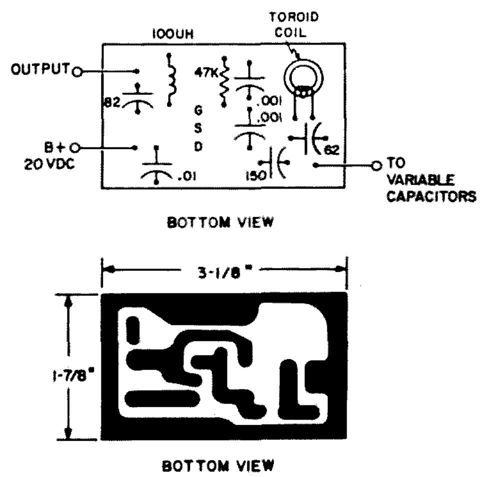
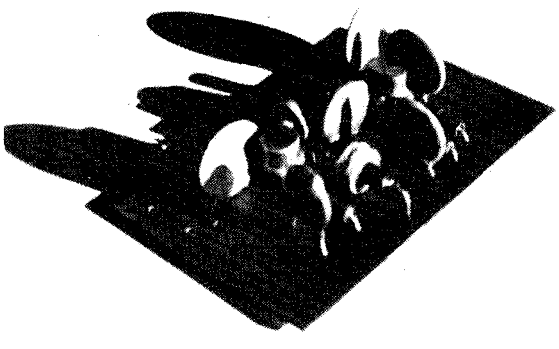


Fig. 7. Oscillator board. The toroid coil form is ½" ferrite (Amidon T-50-2). D, S, and G indicate drain, source, and gate of the MPF-102. See Fig. 1.

used to cover 3.5 to 3.8 mhz. Adding more turns will widen the frequency range, but CW operation is the only mode used, and 'phone band coverage is not needed. There is absolutely nothing critical about the oscillator circuit, and it should cause no trouble if connected properly. If a toroid coil is not used, a slightly larger (200 to 300 pf) capacitor

should be used between the tuned circuit and the gate of the MPF-102. A lower Q coil will require more feedback to sustain stable oscillation. If you experiment with this circuit, you may find that there is a condition between oscillation and non-oscillation. This condition is to be avoided because the oscillator may appear to be working, but is not. Always try the next larger value gate capacitor that will give the stronger, more stable output.

After the oscillator board is mounted, the output is brought out through the bottom of the chassis with a short piece of RG-174 coaxial cable. The power wiring will be taken care of last.



Amplifier board.

The amplifier layout is shown in **Fig. 8**. The only new feature here is that sockets are used for the transistors. This is done to allow trying different transistors in the circuit. Almost any high frequency NPN silicon transistor will work, but the output transistor should be capable of handling at least a half watt of power. In this case, a heat sink was used on the 40081 to increase its dissipation. The circuit board is bolted into a rectangular cut out in the chassis as was done with the power supply.

The control circuitry and power wiring are completed last. No printed circuit board is needed here. The circuit may vary depending upon the type of transmitter the vfo is to be used with, and the type of relay used. The builder may even wish to reverse the process and have the vfo switch operate the transmitter.

Final Alignment and Adjustment

Other than calibrating the oscillator, there isn't any. These circuits have withstood many weeks of breadboarding, experimenting, and redesigning. When assembled properly they

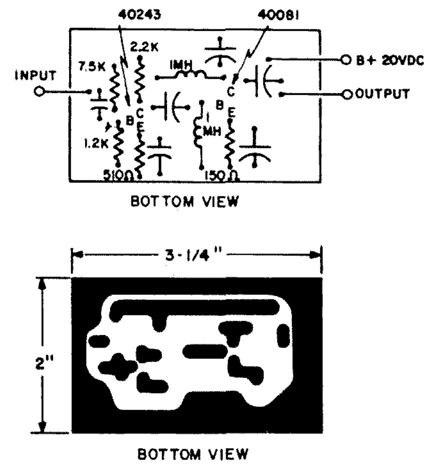


Fig. 8. Amplifier board. All capacitors are .01 disc. C, B, and E indicate collector, base and emitter of transistors. See Fig. 2.

will be stable and reliable. When the final version shown in the pictures was assembled all circuits worked the first time as was planned.

The builder may wish to modify the tuning range of the oscillator. On higher frequencies the band is quite crowded into a small portion of the dial. If bandspread is not considered adequate a small capacitor (50 to 100 pf) could be placed in series with the tuning capacitor. This, of course, will reduce coverage on the lower frequency bands. Perhaps a bandswitch could be used in the circuit to change the tuning range, but a mechanical linkage would be a complicating problem.

If large temperature changes are a problem, you might try temperature compensating the oscillator. Drift, however, is not serious. In one experiment this vfo circuit was built in to the same chassis with a pair of 6146's. A fan was used to blow the hot air from the tubes away from the oscillator. This simple solution was all that was needed to stabilize the oscillator.

Conclusion

This vfo has the best performance of any circuit I have built of this simple a nature. Better performance could be obtained using the same oscillator circuit in a heterodyne vfo, but this would be much more complicated. Considering the required effort and performance, this vfo would be an excellent project for the amateur who has had some construction experience and wishes to add vfo capability to his rockbound CW transmitter.

...WB6BIH

LETTERS

The article VSWR-An Outmoded Parameter by VE2AXQ in the April 1969 73 Magazine may offer a new cause for you and 73 Magazine.

In the article the author proposes to do away with VSWR on the ham bands where he says it doesn't belong and relegate it to the microwave bands where it does belong, according to VE2AXQ.

One can hardly argue with VE2AXQ's contention that there is no room for VSWR on the ham bands and I'm with him and in favor of banishing trouble with that dern VSWR and even plain old SWR and what with all the other troubles about we sure don't need any more of those VSWR's.

It doesn't really matter that we get rid of VSWR by substituting for it the reflection coefficient, a very close relative, and it doesn't really matter that VSWR is one means of expressing the reflection coefficient just so long as we banish VSWR and SWR from the ham bands. It makes no difference that both VSWR and SWR and the reflection coefficient issue from and are functions of the same condition because over the years just having SWR's has become a hateful and distasteful thing on the ham bands.

It is to be noted that of all the different designations for reflection coefficient that have appeared in articles and reference works on transmission lines that VE2AXQ has wisely chosen Gamma. Gamma has a pleasing sound with a nice ring to it. Some writers designate reflection coefficient by p (Rho), others by a small K, and still others by a capital K. I don't think that the small k really stands for or is short for anything but it is believed that the capital K is short for Krutchley (K for Krutchley) who I am not familiar with but who probably had something to do with the discovery of reflection coefficients. But anyway, note the far better sound of Gamma as opposed to Krutchley. We can all be thankful that VE2AXQ selected Gamma. Can you imagine how distressing it would sound for some guy in QSO on the ham bands to remark "I gotta QRT now because I got some dern high Krutchleys." It wouldn't do much for the image of ham radio.

In this budding campaign to banish VSWR's and SWR's from the ham bands there is bound to be considerable squawking from a great many hams who own SWR meters and who may therefore be opposed to progress. Noting the 73 Magazine Editor's comment on page 2 that he pays the fastest and mostest for good articles immediately leads me to the conclusion that I can be of great assistance here in easing the grief of those many hams who own SWR meters and who would otherwise tend to stand in the way of this noble cause save for my services.

What I propose is a lengthly and well-paid for article as a follow-up to VE2AXQ's piece which will explain in great detail to the present owners of SWR meters how they can convert them at practically no cost and no effort to read Gamma rather than SWR. I would, of course, have furnished the information free as a public service except that I don't want to interfere in any way with your announced policy of paying the fastest and mostest.

Please advise the fastest the mostest that you will pay for my proposed article.

E.A. Wingfield, W5FD
26 Belmont Drive
Little Rock, AK 72204

I would like to take this opportunity to thank you, Kayla and the staff for the Swan 260 you gave away at the Dayton Hamvention. I had it on the air the day it arrived, and have a whole slew of contacts from 20 sideband and cw. The dipole I strung between the balconies is outperforming my beam with depressing success–but at least rotation is a little easier under the tri-bander.

My sixth contact was Kayla, and at the time, she was mobile in Texas. I had to run off to class though and only got to talk with her for a few minutes.

Being a college student, and especially a poor college student, the transceiver sure was a welcome addition to the shack. Since I'm in the co-op program here at school (EE) I spend half my time at home, where I drive 70 miles a day to work and back. My HT-32 was never designed for much mobile work and the Swan seems to be the answer to a long standing prayer.

I hope to be meeting you at a future hamfest, or perhaps on 20 one of these days. (say about 14250, fifth layer?) Once again, pass my thanks to all concerned and keep up the good work.

Bill Chidester, WA4ZCL/8
Box 500, Sawyer Hall
University of Cincinnati
Cincinnati, OH 45219

In your May issue by W8GI, Who's Who in Amateur Radio, you left out the best Guitar Picker in the Whole Wide World. . .Mr. Chet Atkins is a Ham and right now can't remember his call but I think he is as great as anyone that was listed, so let's get on the ball and quit leaving out us Hillbillies down here in Tennessee.

Ernest Tucker, W4MQV
Box 251
Fayetteville, Tenn.

I found K9AAU's short article ("A New System for Learning Morse Code," April, 1969) very interesting. When I learned the code a few years ago, it was by being exposed to the alphabet in groups unlike those suggested in the article; and it was necessary to suppress or unlearn some letters while being introduced to others. I am a nearly total cw operator and am always interested in improving my ear so after reading this article I realized that I am one of those with the habit of deciding what the letter is before the character is finished. Consequently, it is often necessary to change my mind after the character is complete. and this takes up time so it is a definite impediment. With this in mind, I took some practice with the intention of losing this habit. It took me very little time to realize that if I actively tried to stay a letter or two behind the sender, I could hear the complete char-

acter before I had to decide what it was. This immediately gave me at least a three word per minute increase in speed with a very accurate copy. Copying behind the sender is not a new idea by any means, but when this method is understood in light of Mr. Erwood's article, it can provide a springboard for someone like me who is stuck at a good, but not yet 20 wpm speed to gain the extra few words to upgrade.

Frank E. Wargocki, WA3AYW
2602 Orthodox Street
Philadelphia, PA 19137

As I sit here listening on the ham bands, it makes me wonder if the amateurs in the states know what kind of signals and how many signals are getting through to Vietnam. Apparently not, because I listen to stations over in this area, approximately, call them and receive nothing but a snub in return. It's a pitiful thing.

But, that isn't the reason I'm writing this letter to you. The first reason is to congratulate you on your forthcoming marriage to K4MWS and to congratulate you the fine job you've done in editing 73 for the past 22 months. Believe me when I say that I've really enjoyed your work.

While reading the April copy, though, I came across your editorial and it really stirred me up, to put it lightly. You mean to say that our Fraternity is going to let someone cut us to nothing and libel the best hobby in the world, without standing up and speaking their feelings on the matter? Ma'am it is a very good thing that one soldier is over in Vietnam, because I'd be doing some tall talking if I were capable of it. I can't feature just how weak people have become in helping out their fellow man and not ask for something in trade.

Of course, I'm speaking of the case being brought against Ansel Gridley, W4GJO. I'll say this, that anything I can do and anything that I can say to help will be said. If the man that is bringing this action against Ansel would concentrate his efforts on something that would help people instead of trying to hurt someone that was BETTERING himself, I don't think I would be writing you from my present location! The money he has spent on bumper stickers and advertising could have been used to write letters to Congressmen and to prominent citizens to help cure situations like Vietnam. That would be money well spent if he has enough to throw away!

About the magazine now. It is great, but how about some construction articles with analog circuitry in transceivers to make them automatically tune themselves?

One more thing before I close this almost editorial, here at AB8AS we average only about 1200 phone patches monthly. And guess what is the cause? No contact stations! With over 250,000 hams in the United States and many of these fellows belonging to the different MARS programs, this is a pity. All of the services over here have a MARS program and they all suffer this same question.

If any fellows interested in patching for RVN stations really feel that they could spend some time helping these stations out, we suggest that they contact their area MARS director and request authorization to work with RVN stations. Believe me, all help would be gratefully appreciated and we could better serve these fellows fighting over here. They deserve it don't you all think?

Thanks a lot, Kayla, and tell them to keep up the great work after you've gone.

Sgt. Ronald L. Berry, WA5BUG/XV

Congratulations to Kayla on her marriage and becoming a Floridian. She showed plenty of sense as your Editor and even more by coming to the Sunshine State. 73's loss is our gain. Hope to hear W1EMV/4 on 75 or 40 meters soon.

Ken Stewart, W4SMK

Quite a rational editorial of yours in 73 Magazine for May, 1969. Can't find anything to dispute your reports in it, and maybe it is about time that we amateurs realize, that with the coming of solid state, transistorized gear, intregated circuits, etc., that service on these rigs will no doubt be done by the manufacturers or service centers. The day of the present amateur having the proper service equipment to do an A-1 job of testing this new type gear is about extinct, Wayne, so lets just face it.

We take our cars to the garages; call the plumbers to fix our leaky pipes; call the piano tuner in to tune the piano; call the TV service man to fix our TV sets, and especially those in color; call the electrician in to put in some new wiring, and NOW—this sophisicated ham gear is right in the same vein.

The ARRL talked about "appliance operators" within the amateur ranks a few years ago, well, "They ain't seen nothin' yet!" Just give this new breed of ham gear using transistors, intregated circuits, solid state, etc., a few years on the market, and we all better have some good packing cases to ship the stuff back and forth to the manufacturer for needed repairs.

Charles Boegel, WØCVU
1500 Center Point Road NE
Cedar Rapids, IA 52402

My article on Learning the Morse Code in April has kept me busy answering letter. Purists may want to correct lesson three to read KCYDX6B, lesson 4 to read NTJPW1 and lesson 5 to read LRA2FU. Readers may be interested to know that reversable errors (A mistaken for N and N mistaken for A) plots a nice tree or chain with no exceptions! The non-reversable condition (you put down B when you hear J, but do not put down J when you hear B) is also plottable and a real brain twister. I've a bottle of aspirin reward for anyone solving this simple yet complicated problem.

Robert Erwood, K9AAU
2823 W. Lyndale Street
Chicago, IL 60647

Just a suggestion you may be able to use in your campaign to re-vitalize amateur radio.

Under current income tax laws donations of property to non-profit schools may be classed as deductions to income, thus reducing the donors tax liability. It is possible that many amateurs have obsolete, but operable equipment which could be donated to a nearby public school to stimulate interest on radio. The fair value of tax equipment or parts thus donated may be reported as a contribution under current tax regulations. If tax dollar amount is large it is recommended that tax prospective donor get more detail from the nearest Internal Revenue Service office.

George P. Firmin, WA4FSK
2193 Bollingbrook SW
Atlanta, GA 30311

Just returned from a stay in the hospital and am rushing my check for $6.00 to renew my subscription to 73 for another year as I do not want to miss an issue.

Must tell you I went in with loads of reading material as I have already passed the code portion for my Conditional General and have been waiting for the theory exam. I never opened any of the books and turned down friends offers of books etc. So when 73 came in, my O.M. told me he didn't bring it in - as I didn't seem to care to read - well, spurious radiation flew from WA2PGR to O.M.'s receiver (ears) and I must tell you upon reading it, all the medicine in the world couldn't have cheered my up more than Bob Mannings' article for May "In the beginning."

Marian, WA2PGR

Dave Middleton's letter to you in the May issue in which he asks "why are so many licensees who are now permitted to utilize the 'restricted' segments, still holding forth in the cluttered-up sections?" prompt this reply. . .namely, in spite of the fact that I have now held my Extra Class since Sept. 29th, so many of my very good friends are still restricted to either the General or Advanced portions and transceiver operation being what it is, it would just leave me with practically nobody to talk to if I stuck exclusively to those portions of the bands permitted by my Extra status.

I like my freinds better than my privileges. 'Nuf said?

Clayton Gordon, W1HRC
Box 85,
West Millbury, MA 01586

I'd like to know how many write in about the technical errors of the May cover, W7NVY: (A) You raise the antenna outside the guy wires; thus, the director goes up first with the boon vertical to the ground, and the reflector is the last to leave the ground and is held out by ropes till it slides on the guys. As drawn, the section of the tower hidden from view would have to have two guys on it, but I assume the artist lost his prospective here and couldn't figure how to get himself out of the deal. (B) A good man on the tower would have another foot of belt out and would not have his arm around the mast, nor would he have the wrench in his hand with people directly below him. (C) You don't raise the beam with a sling. Where is the leverage to get it higher than the guy on the mast? Either use a mast mounted jin pole or hook down on the boom to give height when up. Strain insulators aren't the right kind either, or else are wired wrong.

The colors are nice.

As for K1YSD- -more, more, more.

Arthur W. Brothers, W7NVY
Salt Lake City, UT 84313

George Taylor, W4PZS, whose letter appeared in the May issue of 73 is so right in his views on incentive licensing. I say three cheers for his ability of putting into writing what I've been thinking for a long time.

During the controversy, in a letter to the ARRL, I pointed out that this is equivalent to allowing the better auto mechanics to use the class A highways and relegating other persons, who may be excellent drivers, to back roads.

I have been an amateur operator since 1931 and have subscribed to QST whenever I had the money but like many other hams I dropped out of the ARRL membership with the incentive licensing issue.

So you see, George Taylor is not alone in urging you to pressure the rescinding of this ridiculous rule.

Yours for better operating procedures.

Theodore DeCrescenzo, W2DAD
244 Columbia Ave.,
Jersey City, NJ 07307

I agree with most of what Wayne (March de-W2NSD/1 has to say. The whole ARRL should be in Washington. I lived and worked there for 30 years. I worked with all the associations (and there is one for everything). It's not only advisable, it is totally necessary. I agree also with the need for publicity. . .we must be heard and felt, but we'll never do it the way things are going now.

Hank Bray
1324 West Knox
Tucson, AZ 85705

We wish to thank you whole heartedly for the article (May, page 46) on QRP operation by Arthur Child, W6TYP. This article is very interesting, informative, and will give our Club a very big boost. Thru no fault of yours, the office of Corres. Sec. was changed from K7LNS to K3YNN (me). Am a steady reader of 73 and do sincerely hope that you keep up such a marvelous job for 73 magazine.

Elmer J. Worth, K3YNN
946 Franklin St.
Reading, PA 19602

The article "Education and Ecstacy" (April, page 14) was beautiful. It takes me back 35 years. Mr. George Leonard has hit upon the difference between the Old Timers and the modern amateurs. The old timers had a feeling of ecstacy gained from the thrills of the sound and flash of the crashing spark, or us youngsters by watching the 852 glow a cherry red while listening to the hum of the pole peg and watchin the house lights blink. Those days it was easy to build a rig and receiver.

What have we today? Cold, hard, unhuman, solid state. No color, no hum, no beauty! I pity the poor educator who has to overcome the barrier today.

Ed. Marriner, W6BLZ
528 Colima St.
La Jolla, CA 92037

The biggest mistake the average ham makes when he finds himself being intentionally jammed by someone with a serious mental problem is to answer the idiot. Almost all receivers are equipped with a little knob for tuning which can change the game to hide and seek. It also helps to change over to CW as few of the morons can copy over 13 per.

Charles Larson, W9JWH
RR4, Connersville, IN

Out here in the western Pacific I work for IT&T/Federal Electric Corporation as an electron-

ics tech. A chap who left for the U.S.A. left behind a Heath HW-16 that he had built for 21 megs only, leaving out the band switch complications and so forth. He left behind only one crystal that is for the low end of 21 megs CW. I know how you feel about incentive licensing and it has its pros and cons. One thing it has done for us is to keep clear the low end of 21 megs so DX can work DX without US interference (QRM). With the low power of the HW-16 I have worked DX I never dreamed of back home without having to QSO any W's. This sounds selfish, but when you're not here and work those real rare ones when no one else is on the bands, it's sensational. I know sigs are coming through from the USA 'cause I can tune up the band and hear the Generals and Novices. Unfortunately I can't qso them due to a lack of crystals. I won't be here long enough to import any since I did have hopes of giving some of the Novices their first KX6. I thought I would add one bit of sentiment about the incentive licensing that from the DX man's standpoint, it's great because it's keeping the USA gang off the DX frequencies.

Jim Jaeger, KX6KR
Marshal Islands

In the February, '69 issue of 73, page 10, Mr. Matthews' schematic does not include an important safety component. . .and rf choke across the output to ground. The rf choke is normally included in this place on a linear to put the high voltage to ground in case the blocking capacitor (c-11) should break down.

Keep up the great work with 73. Thank you.

Wayne L. Jinske, WA9SSH
Route 1, Box 157A
Cluster, WI 54423

As you can see from the address I am living in Brooklyn again. My company decided that they needed someone in the New York City area, so I deported from sunny California. I found the article by W2ZRX/4 on "The VHF Vacation Special," very interesting and useful. The antenna works quite well. I found that if two sheets of "Oaktag" (heavy paperfinished cardboard) were taped together the antenna can be mounted on the "Oaktag" with an office type stapler. Staples are also used to mount the coax feed to the antenna instead of taping the coax to the antenna (better electrical contact). The antenna can be mounted either vertical or horizontal and relocated easily. By building the Antenna on the "Oaktag" all I have to do is take down the Antenna, fold it up and store it.

Dave Abramowitz, WB6JEV/2
2520 Batchelder Street
Brooklyn, NY 11235

Compliments to Mr. Sam McCluney and to 73 for presenting the revolutionary audio filter as described on page 60 of the April 1969 issue of 73. The selectivity available with this device has enabled us to make QSOs easier and to communicate the desired information in shorter time than was previously possible.

However, it was found during attempts to con- Mr. Gus Browning, W4BPD, on his travels that even this filter was insufficient to cope with the maximum useable interference level (MUIL) on filters' performance and a solution was found which may prove helpful to toher hams.

The copper conductor specified in the article was removed and replaced with a low resistance silver conductor cut to a length of exactly 0.73051." The length is extremely critical to the performance of the new filter and was determined after lengthy experimentation.

The performance of the new filter is even more amazing than the original. Lab test so far have indicated a filter selectivity of -0.3 cycles. The negative term applied to the filters bandwidth indicates the filters ability not only to eliminate all QRM but also its capability of internally amplifying the desired signal. The numeral following the decimal point indicates the amplification in decibels.

The obvious advantages of a filter of this selectivity are that much less on-the-air time is required than previously to communicate the same amount of information. The amateur will now find much more time available to spend in keeping up with current states of the art, with his family, and with other activities he previously was unable to find time for.

Again, congratulations on this article which is in tune with most of the other revolutionary article which 73 published as a service to the amateur.

Jon P. Zaimes, WA3BGN
6117 Smithfield Street
Harrisburg, PA 17112

For a long time it has seemed to me that the Technicians are the forgotten people of ham radio in the band frequency shuffle. I believe that a large percentage of "Techs" are home brew builders and tinkerers, and that they should be encouraged to maintain their interest and curiosity in ham radio for the good of all radio. One way to do this would be to allow them to use a small portion of the upper end of the large 10 meter band so that they could participate in more reliable DX conditions.

By the end of this year when more of the lower end of 6 meters is allocated to Advanced and Extra Class license holders, everyone else using this band will be forced closer to TV channel 2. That will cause more TVI complaints and I don't believe anyone needs more of that!

The Technicians have to pass a theory test

which is similar to a General test and they are competent and able to handle their equipment properly.

It would be nice to hear some discussion and see some action on this suggestion. I know that ARRL petitioned the FCC to keep the entire 6 meter band open for all classes, but was turned down. However, the idea of "Techs" using a portion of 10 meters was not laid before them.

Thank you for any consideration you may give this idea.

R.L. Gardner, WB6VON
3695 Strong St.
Riverside, CA 92501

I want to thank you very much for the Advanced Class License articles, and make a few comments on the FCC exam. I studied each article carefully, month by month. At the end of the series, I read through each one again, at about one per day. I guess I was very well prepared for the exam was no problem and I feel much more knowledgeable and competant. I am very grateful to you; just hope I can do as well with the Extra Class!

My exam was in San Francisco, Friday at 8:30 a.m. If you missed 8:30, as some hams did, you had to wait until 9:30 or ten to be "run through" again - or come back next week. This all seems unfair to working people. Couldn't they schedule more times? And what about lunch hours, or late afternoons, or evenings?

The exam room was so crowded with desks that it was not possible to get between them. The noise of people clanging through the desks, plus the room's being used for all applications, verbal questions, eyeball QSO, made a nearly impossible examination atmosphere.

The exam, itself, contained a variety of poor questions. I mean poorly composed questions as well as poor questions. One question asked about the best frequency for communication over a "long distance." The term "long distance" was too general for the variety of answers that were possible. Is two hundred miles a "long distance?" If so, what is two thousand? The subject matter could be quite relevant in an emergency.

Second, I remember at least two questions which were not really amateur radio questions, but were "tricky english" questions: Unusual word orders, synonyms of what universally appears, with the result that more than one answer was actually possible. If it uses "plain english" on the code test, why can't the F.C.C. use "plain english" on the written? After all, our job is to be tested for our radio knowledge and competance, not to be alertly playing examination word games.

Third, the rules and reg.s question on my exam was one which I would never rely on my memory for. Knowing band edges is one thing, but amateur-to-F.C.C. communications regarding portable operation are complex enough to call for careful & thorough study of the rules and reg.s as you communicate with them, and hardly a simple "memory" questions.

Nowadays, they don't grade your exam on the spot; they claim they are too busy. I wonder about this: the exams are only one morning per week. There were less than two dozen people taking exams over the two hour period I was there. Grading is simple and fast on their answer sheets. and it used to be no problem to do it, several years

ago - just a courtesy to let you know before they sent it away. And then the absurdity of hoping not to get any mail for ten days, because if you don't get any mail it will mean that you passed! Like a sort of undercover organization: if you don't hear from us, everything's O.K.

We amateurs are being asked to upgrade ourselves. I think the F.C.C. ought to upgrade itself, too, in respect to the radio amateur. We should expect and demand that the F.C.C. shape up. In the area of exams, there should be a better calender. a better exam room atmosphere, a more to-the-point examination, and better grading feedback.

Steven Saslow, KFBDK
1300 Grove St. #4
Berkeley, CA 94709

In the latest issue of 73 (April, 1969), you stated that since Kayla is leaving your staff, you will be featuring lots of articles on your favorite subjects, VHF, RTTY, Fax, etc. That's why I'm writing this letter.

As an avid believer in experimenting with new modes of amateur activity, I have bounced around from one project to another with the enthusiasm of a young puppy.

I have found though, that many hams like to use such phrases as "Somebody should write a letter to the F.C.C. on this or that matter." But by and large that's all they do. They keep repeating the phrase over and over but never seem to practice what they preach. Well this is where I come in, Wayne, I don't like to work any harder than the next guy, but I do get sick and tired of everyone talking but nobody doing anything about any given ideas. So I generally proceed to write letters and, in general, stick my neck out for any cause which I have a personal interest in. So, now finally, I am getting to the real purpose of this letter.

You say you're interested in Fax and VHF. Well, Wayne this pet project concerns both. Let's take the history first. A few months ago, Western Union released a large lot of desk-top facsimile units (trade name "Telefax") which is manufactured by the Seeburg Co. These units reproduce printed material onto specially treated 4½ x 6½ blanks. The machines are self contained and operate on the principle of a steady 2500 hz tone which is amplitude modulated directly by the change in intensity of reflected light from the original. The original is fastened to a drum which revolves and traverses laterally at the same time. The light source is directed onto the original and reflected back through a series of lenses, through a rotating "chopper wheel" and finally striking a photo sensitive tube. The "chopper wheel" produces high speed light pulses on the photo tube. The output of this photo tube generates the audio tone of 2500 hz. The amount of light reflected from either lines or shading on the original varies the amplitude of the light striking the photo tube. This amplitude modulated, steady tone is fed directly into a low impedance microphone circuit in the transmitter. The station receiver feeds the incoming audio signal directly from a speaker connection on the receiver to the input of the Fax machine for the receive mode. A sensitized paper is attached to the same drum as uded for transmitting. Now, however, when the unit is actuated on the incoming mode, the drum begins to rotate and traverse. At the start of motion, a small stylus swings over and rubs on the paper. A high voltage spark passes through the sensitive paper to the drum itself. This spark varies directly with the amplitude of the incoming audio signal. The traces to appear in relation to the intensity of the spark. This, basically, is the principle upon which the machines operate.

These machines were sold in Cleveland, Ohio and are being sold by other surplus outlets throughout the United States at a selling price of from $10 to $20 apiece. Many of us in northern Ohio purchased these units.

Now the VHF part. There has been a very high level of activity on 2 meter FM in northern Ohio recently. We operate converted commercial gear using 146.940 mhz/s as an operating frequency. Other frequencies spaced at 60 khz intervals are also used. We operate only FM and most of us have both base and mobile station capabilities. Effective communications of 50 miles are commonplace. There are 2 repeater stations within our effective operating range which can be utilized to increase our coverage. I am also a participant in a small local autostart RTTY net on 146.700 mhz/s using AFSK. (RTTY, by the way is a phase of ham radio very close to my heart. See 73 for January, 1969, for my feelings).

To continue, when these Fax units were purchased, many of them were immediately placed into service through the FM units. Utilizing this mode, the fax pictures are extremely clear and sharp. However, someone discovered that the type of emission that was being used (type F4) was not authorized in the 144 to 147.9 mhz/s band. The only type that is authorized on 2 meters is type A4 (AM Facsimile) emission. The few units which had

already begun operations were immediately removed from the air. Then everyone started asking, "What can we do now?" A suggestion was made that everyone owning one of these fax machines should write to the F.C.C. and request special permission to operate them using type F4 emission. After hearing much talking but seeing no action, I decided that I would write the F.C.C. a request letter myself. As it turned out, mine and one other request were the only ones received by the F.C.C. as far as I can determine. In due course of time, I received an answer which, about as I had expected, denied my request on the basis that they did not believe it advisable to issue temporary authorization such as the one requested. They did state, though, that I was free to file a petition as per the procedures they outlined to have the Commission's rules ammended. I again brought this out over the air and agian I heard the same old cry, "Somebody should file a petition with the F.C.C." Again after hearing a lot of talk but seeing no action, I took up pen in hand and drafted a petition asking to have part 97.61(a) of the Commission's rules amended to include F4 emission. I then sent this petition to Washington. Again after due course of time, I received a copy of a schedule of hearings and found that my petition had been accepted for hearings and was listed as file number RM-1429. No mention was made of when the petition would come up for hearing before the Commission. I let the fact that there was now a petition at the F'C.C. be known and most of the fellows were quite pleased. A few of the interested hams in the area then sent comments to the Commission regarding the petition (all favorable, I hope).

Now to the heart of the matter, Wayne, I can campaign over the air to the hams in the Akron, Canton, Youngstwon, Ohio areas myself but I am in no position to carry the message throughout the country. I have seen ads from surplus centers in St. Louis, Mo., New York City, and other places which are selling these fax units, so it stands to reason that many hundreds of hams could possibly benefit from the acceptance and subsequent adoption of my petition by the F.C.C.

Wayne, since you have been a crusader for the little fellow and you are highly respected in ham circles, I felt that a little boost or some promotion by you of the RM-1429 petition through 73 magazine would help tremendously.

So in summary, Wayne, I am asking for some help from you in spreading the word that there is a petition on file with the F.C.C. and anyone interested in operating Facsimile on 2 meters using FM equipment should please send their comments and support to the F.C.C. in Washington, D.C.

The comments must be typed, double-spaced, using 1½ inch left margin and be filed with (1) original and 14 copies. All correspondence and comments must refer to the file number RM-1429. (These are all Commission's rules and any correspondence not conforming to these specs can be ruled unacceptable and not valid.

Remember, A4 is allowed on 2 meters so let's have F4 allowed too. Keep the file number in mind: RM-1429.

Thanks, Wayne, for your time and we here on 2 meter FM all appreciate whatever help you can give us.

James L. Turrin, WA8DCE
Box 245
New Philadelphia, OH 44663

MAYDAY - EMERGENCY

Liquidation sale due to heart attack

MAYDAY EVERYTHING GOES

JUNK for sale. A large assortment of test sets, power supplies, amplifiers, medical electronics, originally bought for stripping purposes, but didn't get to do. CASH and CARRY only. Sorry, no mail orders accepted.

SPECIAL DISCOUNTS

It may pay for a group to get together or a club to pool their orders, shipment to one address only, no split shipments, to take advantage of the higher discount.

10¢ ea. lb. + 10¢ ea. tube, 50¢ ea. meter

All items advertised since Jan. 1968 in HAM RADIO & 73, and listed in my "GOODIE SHEET" for May 1968 and Feb. 1969, except the above "JUNK", coax connectors, coax cable and the few items previously reduced from my already low prices; for sales $10 and up a discount of 5%, for sales of $50 and up a discount of 7½%, for sales of $100 and up a discount of 10%.

Discounts only apply on mail orders, or sales at the store:

Sale ends Aug. 16th. Due to recent heart attack the doctor has ordered my retirement. PLEASE include sufficient to cover postage, or other shipping charges. For heavier shipments, please specify routing–REA, motor freight, or bus express.

IMPORTANT NOTICE—store hours, Monday & Thursday 10:00 a.m. to 2:00 p.m., Saturdays 9:30 a.m. to 2:00 p.m. If you want to come at other times, PLEASE advise sufficiently in advance, by letter or call home phone 312-SU4 4426.

BC Electronics 2333 Michigan Ave.
Chicago, Ill. 60616

Ameco PX 62 Transmitter Near new.	$100.00
Mosley CMI Receiver	$ 80.00
Heath VHF 1 Seneca Transmitter	$125.00
Surplus BC 348 Receiver w/Ac Power	$ 70.00
Linear Systems Century Power Supply 12v DCN, 2200v DC 450 MA Out For 1 KW Mobile	$ 75.00
TS-323 Frequency Meter 20-480 Mc. Like new	$125.00
NLS 450 DVM, for voltage ratio measurements. Appears good, not checked	$ 95.00
G R 1110-A interpolating Freq. Standard	$ 50.00
PRD 650-A universal power bridge no bolometer. Exc.	$ 40.00
TS-375A/U VTVM very good.	$ 20.00
Federal 804-CSI Standard Sig Gen. 8-330 Mc. Exc.	$100.00
Brush RD-5616 Servo Analyzer new. less covers	$ 50.00
Brush BL 202 2 channel oscillograph. Good cond.	$ 45.00
Brush BL-360 Universal amplifier.	$ 35.00
Brush BL 932 or BL 962 amplifiers, each	$ 35.00
Atchley model 33 servo amp like new	$ 35.00
H P 91390 This consists of an H-P 400-C AC VTVM and a 410 C VTVM mounted together on a rack panel. Very good, less AC probe for 410-C	$100.00
Waterman S 15 A Twin tube Pocketscope Very good	$ 65.00
AN/UPA 18 detector amplifier Exc.	$ 35.00
Lambda model 28 DC supply 200 235 v 100 ma Exc.	$ 30.00
Kin Tel 50B25 Absolute DC power supply Very good.	$120.00
Philbrick r 100B dual pwr supply Good cond.	$ 22.50
Esterline Angus AW recording ma meter, mounted on rack panel. less pen	$ 70.00
APR 4 receiver, less plug ins 115 v 60 Good cond.	$ 45.00
TS 13/AP X band test set power & freq Exc	$ 35.00
RF power bridge model 94 E New, with accessories	$ 50.00
Ballentine 302-C AC VTVM Battery operated	$ 30.00
GUARANTEED USED HAM GEAR	
Galaxy V with AC supply	$300.00
Drake SW 4A SWL receiver Like new.	$225.00
Heath DX 100 xmtr	$ 75.00
Heath Apache TX 1 xmtr	$110.00
P & H LA 500 "Spitfire" linear 1 Kw. PEP	$ 75.00
P & H PSA 1000 mobile supply for LA 500	$ 65.00
Hallicrafters SX 111 receiver	$125.00
SBE 34 SSB transceiver with mic. Exc.	$275.00

JEFF-TRONICS

Please add sufficient shipping charges. Any excess immediately refunded. Send 10¢ for flyer. Free with order.

4252 Pearl Rd. Cleveland, Ohio 44109

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★ **Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

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★ **For $1 extra we can maintain a reply box for you.**

★ **We cannot check into each advertiser, so Caveat Emptor . . .**

SPECIAL CLOSE-OUT SALE. Rectifiers, Transistors, and many other Electronic Parts. Lowest prices. Send, 15¢ for Catalog. Electronic Components Company, P.O. Box 2902 S, Baton Rouge, La.

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NEED A VARIABLE CAPACITOR FOR that home brew project? We may have what you need at more than 50% below regular amateur net. Send for free flyer. A.R.C. Sales, 181 E. WilsonBridge Rd., Worthington, Ohio 43085.

FILTER-CONDENSERS: Aeroovox Oil Filled 100 mfd. @ 3000vdc Condensers. $30.00 each. Basil J. Weaver, 1821-C-Ave. M, Lubbock, Texas 79401

AMATEUR RADIO CERTIFICATE: Display impressive 8 1/2" x 11" personally endorsed certificate in your shack. Send $1.00 to, Amateur Radio Certificate, Box 244, Miami (Kendall Br.) Fla. 33156.

WANTED ANTIQUE RADIO and wireless equipment. Also radio magazines of teens and twenties. Also buying supply catalogs, Duck, Manhattan! etc. Farrell, 2252 Dixie Pontiac, Mich. 48055.

"TOWER HEADQUARTERS!" 11 Brands! Heights aluminum 35% off! Strato Crank-ups low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog-20¢ postage. Brownville Sales Co. Stanley, Wisconsin 54768.

XW8AHT WANTS early and oddball tubes, (Western, etc.). for collection, cheaply! Write or send Polaroid. S.J. Murcek, 1305, Rainbow, McKees port, Pennsylvania 15131.

SWAP - Cadre (Raytheon) 5-watt, 5-channel, 110v-12v, all-transistor CB transceiver (plus cash) for 2 meter transceiver. Joseph Boland, 245 N. Levering Hannibal, Mo. 63401.

THE ANNUAL HAMFEST for the Washington, D.C., metropolitan area, sponsored by the Foundation For Amateur Radio, will be held at the Gaithersburg Fairgrounds in nearby Gaithersburg, Mary land, on Sunday the 21st of September from 1000 until 1700 hours.

"CAPACITORS-JUST inherited 52 brand new 140 ufd @ 450vdc capacitors. Will sell for 95 cents each in lots of ten or more. K4IHP - Atlanta.

ANNUAL SOUTHWESTERN Michigan VHF Picnic Allegan County Park - - - -August 3rd. Sponsored by - - -Van Buren County Amateur Radio Club Inc. W8JUU - - -Bangor, Michigan.

RTTY GEAR FOR SALE: List issued monthly, 88 or 44 MHy torroids 5 for $2.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd. Oakland, California 94610

WANTED: BC454 tuning condensers. Part No. 4601 in good condition. Need 50. What is your price and quantity? R.T. Brackman, WA3ACL 120 Chapel Knoll Drive Pittsburgh, Pa. 15238

3000V @ 3μF brand new GE Pyronal oil capacitors $3 each. Can mail, 3-lbs each shipping wt., FOB, P. Wandelt, RR # 1, Unadilla, New York 13849.

ALL EICO: 90 watt CW transmitter $50, 722 VFO $25, 315 Signal generator 75khz-150mhz $40, 147A signal tracer $20, 950 RCL bridge-comparator $15, 1064 0-20 volt supply $35. Also deluxe Vibroplex Lightning Bug in carrying case $20. Realistic dual trace oscilloscope model 102 for ham, tv or audio applications $100. NYC-L1 area only. Marty Barrack WA2ZKR, 326 Glen Head Road, Glen Head, N.Y. 11545.

SELLING: National NCX-3 with plug in calibrator & incremental tuning, mile, SWR bridge, bug, etc. $275; grounded grid 4-250 linear amplifier with plate supply $75; Mosley TA-33 tribander, 10 ft. tower, AR-22 rotator, 11 element two meter beam, masting, etc. $75; Heath tower $30. Hecht, 1584 Greenway Blvd., Valley Stream, N.Y.

KWS-1 LIKE new, will ship $600 Gen. Elect. FM 500 watt 25-50 Mc. amplifier w/prw. supply, no cabinet, uses 4-125's $200 Brand new Kohler 117 VAC 3 phase 180 cycle power plant $200 2-GE Transistorized P/G Line frontmount 150-170 Mc. FM Mobile units $300 each. W9DSV, 715-866-2468 Webster, Wis.

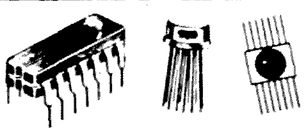
WRL's USED GEAR has trial-terms-guarantee! Galaxy V- $229.95; TR-3 $399.95; Swan 250 - $249.95; SR150 - $299.95; KWM1 - $299.95; 516F1, ACPS - $69.96, HX10 - $199.95; T4X - $319.95; AF68 - $49.95; SX146 - $189.95; HQ170AC - $209.95; HQ180AC - $349.95; R4A - $319.95; Hundreds more, Free "blue-book" list . Write WRL, Box 919, Council Bluffs, Iowa, 51501

Please use your Zip Code when writing 73

3 INPUT DUAL AND GATE

Brand new factory marked and packaged PHILCO-FORD iC's. Flat pack, long leads, each nested in its own plastic protective snap-lid shipping pack. 3 input dual AND gate. We furnish circuit diagram and lead connections. A real bargain for factory first-line material.

#69-100 3 for $1.00; 12 for $3.00



GRAB BAG IC's

Mixture untested IC's, flat pack, dual inline, TO-5. Most factory marked. Package of 12 units W/10 pages RTL and DTL specs. **$2.00**

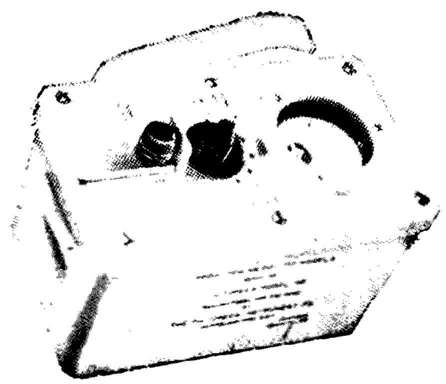
Customer pays all shipping

New catalog #69 now ready

Send 25¢ handling & postage charge.

VARACTOR SIMILAR TO MA4060A

Good for 40 watts at 432 MC, ea. tested in circuit, w/diagram for 432 MC tripler. **$5.00 ea.**



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SURPLUS SPECIAL **$10.00**

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8,192 Wired Core Plane	$15.00
16,384 Wired Core Plane	$19.00

JOHN MESHNA JR.

19 ALLERTON ST., LYNN, MASS. 01904
P. O. BOX 62, E. LYNN, MASS. 01904

TELEPHONE DIALERS (2) Prestodial. Stores 36 telephone numbers and automatically dials any one at push of button. New @ $119. Richard M. Jacobs, WAØAIY; 4941 Tracy; KCMO 64110.

ELECTRONIC TEST and Communication Equipment-Bargains galore Send 25 cts for catalog. Palen Electronics, Box 1536, San Meteo, California. 94401.

SELL: Four-volume set of USAF books on hundreds of military, commercial surplus test sets; 1,500 pages on 'scopes, counters, VTVM, etc. $5.50. G. White, 5716 N. King's Highway, Alexandria, Va. 22303

W.A.R.A. 12th annual Hamfest Sunday August 24, 1969, Newton Falls Community Center, Newton Falls, Ohio. Take Ohio Turnpike to exit 14 and ask for map to Hamfest. Prizes, XYL activities, Swap & Shop. For further information write: W8VTD Box 809 Warren, Ohio 44481.

FOR SALE: Sencore FE-14 FET-VM $35, Data Instruments 536A oscilloscope $70, Mini-AF generator 6803 $30, Kay RF attenuator 432D $30. All like new. Herbst, 39 Lucille, Dumont, N.J. 07628

SWAN 500c & 117xC power supply used only a few hours-perfect best offer, over $395 F. Pulver, 94-10 60th Ave. Rego Park, N.Y. 11373 (212) 5926668.

SELL: 6 meter SSB Transmitter, Heath HX-30, good shape with manual. $150.00 or best offer; FOB Larry Jones 807 Ohio Ave. Ashtabula, Ohio, 44004.

FOR SALE: 6-Eimac 4CX250B tubes (new sealed cartons) @ $20.00 each or the 6 for $100.00 1-Heath Model AM-2 SWR Bridge @ $10.00 Arthur W. Lee Rt. #1 Box 23A North Monmouth Maine 04265. Tel 207-933-2869.

VIOICON - RCA 7735A - $12.00, Toshiba 7038 - $20.00, Test Vidicon—$9.00. Vidicon Yoke & Focus Coil - $20.00. WB2GKF, Stan Nazimek, 506 Mount Prospect Avenue; Clifton, New Jersey 07012.

CRYSTALS for amateurs. All meters: 1 K C at 20pf. HC6/U holders, -093 pins, 10¢ extra. Crystal frequencies 3501 to 3999; 7000 to 7300; 8001 to 8221; 8334 to 8900. K C. $2.95 each prepaid. Add 12¢ for postage. Listed dealers inquires solicited. American Crystal Co. Box 2366, Kansas City, Mo.

THE TOTAH AMATEUR Radio Club will hold it's Annual July 4th family picnic at Lake Vallecito, Colorado, July 4th, 5th & 6th. All interested perare welcome. Please bring own camping equipment. General location is east end of lake. Watch for road marker. Thank you.

THE OAK RIDGE Radio Operator's Club will sponsor the 20th Annual Crossville Hamfest at the Cumberland Mountain State Park July 26-27. For information write The Oak Ridge, Radio Operators Club, Inc. P.O. Box 291, Oak Ridge, Tenn. 37830.

WANTED: Gonset III, #3357 VFO, Manual for #3226 VFO For sale, measurements Model 59 GDO Like new $135.00. J. Gysan, 53 Lothrop St., Beverly Mass.

WANTED 100V, 200V, GSB-100, 32S-1, 32W-1, SSB-100F, HT-32(B), RV-3, T-4(X) (B) in good to fixable condition. Jerry Malone WØMII/1, 27 Maple Ave., Cambridge, Mass 02139.

"HAM-A-RAMA. The 5th Annual Wood County Ham-a-rama will be held Sunday July 6th at the Fairgrounds in Bowling Green, Ohio. Contact WB8AYY, Bradner, Ohio

THE SHAWNEE AMATEUR Radio Association better known as SARA will be holding their SARA Hamfest on the first Sunday in August, August 3, 1969, at the Herrin City Park in Herrin, Illinois. There will be a trading line and prizes. Tickets can be gotten from W9ERI Bill Johnson 502 Kennicott in Carbondale, Illinois 62901.

39TH–ARRL WEST GULF Division Convention August 15, 16 & 17, Amarillo, Texas. For an ideal summertime weekend of ideas, fellowship, entertainment, fun (and maybe good luck) you can't miss at $10.50 for registration. W5WX Panhandle Amateur Radio Club, Box 5453, Amarillo, Texas 79107.

FOURTH ANNUAL Mini-Hamfest, sponsored by the Rockford Amateur Radio Assn., August 17, 1969 at the Boone County Fairgrounds in Belvidere, Illinois. Lunch and refreshments.

WORLD'S LARGEST INDEPENDENT HAM MAGAZINE

August 1969

75¢

AMATEUR RADIO 73

HAM FM HAM

FM FM FM

Moonbounce Antenna

EXTRA CLASS EXAM

40 OVER FEATURE ARTICLES 40

73 MAGAZINE

73 Magazine #107, August 1969

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...de W2NSD/1

Wayne Green

You may have noticed that the increased size of the magazine has resulted in a crush on the contents page. Frankly, this is a problem that we would like to continue to wrestle with. We can continue to give you a thick magazine every month if you will do three things for us.

1. We can't publish articles if we don't have them, obviously. Construction articles are the most popular, so if you've concocted something that others might be interested in duplicating or even just reading about, write it up and send it in. We pay for all articles and we pay the most and the highest. Perhaps humor is your forte? Or maybe, if you can't write it, you can talk someone like Jean Shepherd, K2ORS, or John Campbell, W2ZGU, into writing for us? Simplified explanations of complicated theory are popular.

If you have been working in one of the newer ham fields such as SSTV or FAX. . . tell us all about it. . .sell us on it. . .get more fellows interested. We need lots more info on RTTY, TV, FM and all the other interesting aspects of ham radio. Write! The basic purpose of 73 is to make amateur radio more fun for you. If you can make hamming more fun for others by writing, then see what you can do. What more important thing is there for you to do in this world than make life more enjoyable for others?

We are now publishing more articles every month in 73 than are published by all the other ham magazines combined, so we need your articles. By count, in May, brand X ran 10 feature articles; brand Y ran 12 articles; brand Z ran 8. Total for the three was 30 articles. We ran 37 feature articles in 73 in May.

2. Your support of our advertisers is the reason that we are able to bring you such a large magazine. Many advertisers in our March issue are still exclaiming over the remarkable results their ads brought. When you talk with manufacturers please tell them that you read 73 and want them to support 73 so that you can have more articles. You may be interested to know that 73 is now leading in advertising. In May brand X had 83 advertisers, brand Y had 50, and brand Z had 62. . .and 73 had 87!

Let the advertisers know that you care! If you can convince a few more major manufacturers to advertise in 73, we can bring you even more articles every month.

3. Share the enjoyment you get from reading 73 by getting a friend to subscribe. . .or by sending in a gift subscription for him. You'll be remembered twelve times a year for your generosity. And if you work DX you will find that just about every foreign amateur wishes that he could get 73. Our international subscription rates are exactly the same as domestic ... $6 a year, $12 for three years! And we are, I believe, the only magazine that can say that! This is our way of trying to help DX amateurs. Hams in India and the communist countries have a special problem. . .no currency. They depend almost entirely on your gifts for magazines. Don't you have a few dollars to spare?

There it is. All you have to do is support 73 with articles, subscriptions and a good word to the advertisers, and you will have a magazine that is bigger, thicker, and takes a month to read. It will also be fun. . .and that is what it's all about, isn't it?

ARRL Board Meeting

Another annual meeting has come and gone with little action on any important measures. Nothing was done about setting up PR which would reverse the downward

(continued on page 107)

Listen In on Two-Meter FM Repeater

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For those who don't have a two meter FM receiver and want to listen to the repeater (if you have one in your area) this little converter will do a very good job into an AM radio.

You will recognize this converter as being similar to police converters. (In fact, changing the crystal and repeaking the antenna coil should put a police converter in the ham band).

The unit is built on a printed board 2-1/8 by 2-5/8 inches. The capacitors are all from my junk box and include small round tubular, round flat ceramics and small milar types.

Q1 and Q2 are 2N2996's, but 2N1141's and TIXM10's all work fine on three volts. Three volts was selected because my converter works into a radio that runs on two penlight cells. If you plan to use 6 or 9 volts, R1, R2, R3 and R4 will have to be changed to other values (found by experiment and measuring base voltages and collector currents). My unit, using 2N2996's draws 8-1/2 ma at three volts.

After building, determine by gdo or receiver if the crystal is oscillating at three times its frequency (I tune my 6 meter rig to the fundamental frequency of the crystal or rather its overtone frequency), or if it is oscillating at crystal frequency, it will be ok at 3 times. Then place the converter near your bc receiver loop antenna and tune it to the approximate frequency (your *if* in this case) or, using a signal generator or a signal from the repeater, adjust the converter loopstick for maximum signal or noise. With a signal picked up from repeater, adjust CI for maximum. I am near the repeater and I use about a 10 inch whip for my antenna.

You are receiving FM by slope detection, so tune your bc radio for the clearest reception. Some will be clearer than others, depending how close to the frequency they are. You won't receive them as crystal clear as an FM receiver, but this will let you listen in.

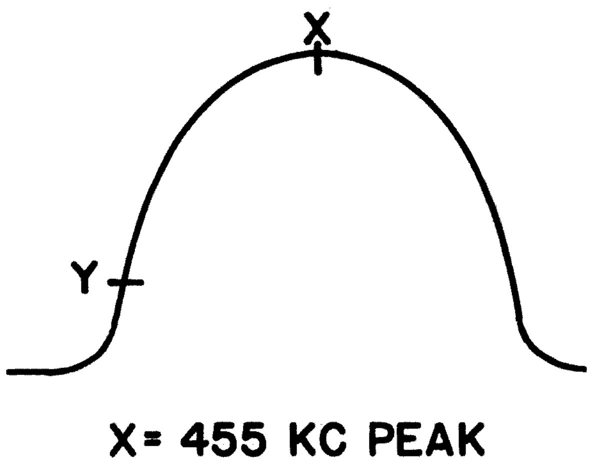

Fig. 1. IF passband used for slope detection of FM signal. Wideband FM will be muffled due to narrow frequency swing between y and x.

Roughly, slope detection works like this (this is a quick and short explanation). Your 455 khz *if* passband looks something like Fig. 1 with the desired AM signal (when receiving AM) carrier will be at "x" or the top part of the curve while the FM signal should be somewhere around "y" (just high enough on the curve to give a signal through the *if*'s). Then, during FM modulation, the frequency swing can be between y and x,

producing a varying signal strength at the detector. As the modulation approaches x on the curve, the *if* is operating with maximum gain and when it is at y, the *if* gain is lower. This varying signal is detected by the AM detector (in other words FM modulation varies the gain of the bc *if* as the signal rides up and down the curve and produces an amplitude voltage at the detector).

Some radios overload easier than others, so vary the distance between converter and bc radio for the best results.

Later, when I scrounge a crystal, I am going to operate this converter into a transistor 10.7 mhz *if*. For those interested, the crystal can be 10.7 lower or higher than the received frequency. The repeater output here is 146.940 mhz, so let's do a little math. Remember that we are using the third overtone crystal circuit as a tripler (that's why we divide by 3).

146.940 + 10.7 = 157.640 ÷ 3 = 52.5476 mhz = crystal on high side.

146.940 – 10.7 = 136.240 ÷ 3 = 45.4133 mhz = crystal on low side.

Either crystal will permit the 146.940 signal to come in at 10.7 mhz, the *if* of most FM sets. The exact frequency of the crystal can be varied according to how much you can swing your *if*'s from 10.7 mhz. In my

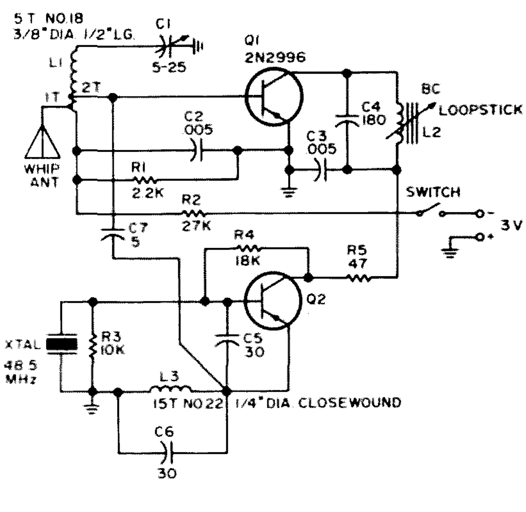

Fig. 2. Schematic of converter for 2M FM repeaters. Or anything else on 2M for that matter.

transistor *if* strip, the slugs vary the frequency very little, less than one mhz.

Getting back to you who plan to use a bc radio. You will have to use this math to suit your crystals and also keep away from bc stations (pick a clear spot on the bc dial). In my rig I used a 48.716 crystal, giving me an injection frequency of 146.148 mhz on the low side of the repeater frequency. 146.94-146.148=792 khz, where I pick up the repeater.

The extreme ends of the bc band, using the xtal on the low side and the high side, are:

146.940 – 1.600 = 145.340 ÷ 3 = 48.4466 mhz low side.

146.940 + 1.600 = 148.540 ÷ 3 = 49.5133 mhz high side.

146.940 – .550 = 146.390 ÷ 3 = 48.7966 mhz low side.

146.940 + .550 = 147.490 ÷ 3 = 49.1633 mhz high side.

There we have it. A crystal between 48.7966 and 48.4466 will permit the repeater to come in between 550 khz and 1600 khz with the oscillator working on the low side of the incoming signal at the antenna, while a crystal between 49.1633 and 49.5133 will permit the repeater to come on the bc band between 550 and 1600 khz with the oscillator working on high side of the signal at the antenna. So, in other words, if you have a third overtone crystal in your junk box between 48.4466 and 49.5133 you can put the repeater into the bc band!

One note of warning of a trouble that cost me a mixer transistor (2N2966). Jamming C3 under the loopstick (which is elevated about 1/4" from the board by a bracket), one lead broke on C3 and when I fired the converter up it was oscillating like mad on the bc band. This made the transistor draw more current and finally destroy itself. So check all parts to make sure a lead hasn't broken. Inspect everything closely and heatsink the transistor leads with tweezers or a long nose while soldering them to the board or, better yet, use transistor sockets.

Good luck and pleasant listening on 2 meter FM.

. . . KØVQY

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An FET Regenerative Receiver for 3.5 mhz and Up

It appears that almost anything which a bi-polar transistor can do, an FET can do better. The simple regenerative 3.5 to 6.0 mhz receiver described here is another case in point.

Three or four months ago I started out to build an SWL receiver for my ten year old son. I used the circuit shown in Fig. 1 which is similar to that in the December, 1966, issue of *73 Magazine*. There were two problems with it which I could not seem to overcome. The regeneration control was too critical, or at least I could not get it to remain stable over more than three or four hundred khz. It required an excessively long antenna. When I got around to measuring the .power into the regenerative detector, it turned out to be .8 ma at 7.5 volts or .0006 watts. I guess you can't expect to rattle the diaphrams in your earphones with that sort of power. Maybe what is needed is a detector in which the regeneration is not controlled by reducing the collector voltage.

This thought led me to recall the old two tube blooper that started me on my radio career circa 1932. It had a VT224 as a detector and regeneration was controlled with a variable capacitor. From that point the circuit shown in Fig. 2 evolved. I used a TIS-34 FET because: (1) I had some on the shelf; (2) a FET acts like a screen grid tube (with poor screening). Any FET which will oscillate on the desired frequency will work in the same circuit (keep the N-Channels and the P-Channels straight).

The results of this new design were as surprisingly good as the old circuit was disappointing. The regenerative control is so stable that you can actually tune the whole range, 3.5 to 6.0 mhz, without touching the control. The oscillator is sufficiently stable so that it could be used for a VFO. It will not only receive SSB signals, but in fact it will sit on the same signal for a half hour or more without any need to retune. I can pick up plenty of signals with a whip antenna (and in some cases no antenna at all). CW signals have a clear crisp sound to them that makes them pleasing to copy.

Before we get carried away completely, I had better acknowledge that this "blooper" suffers from some of the same ills that caused the decline of the 1932 tube-type "blooper." Selectivity is almost nil. Any other amateur within three or four blocks of your location will put one whole amateur

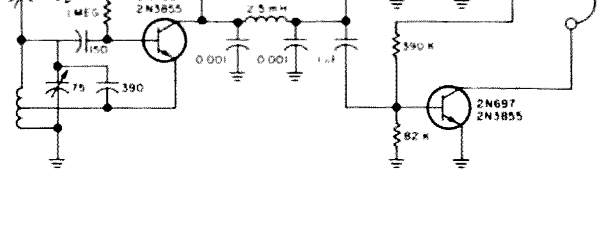

Fig. 1. Circuit diagram for "The Novice Pair," W6JLL, December, 1966, 73.

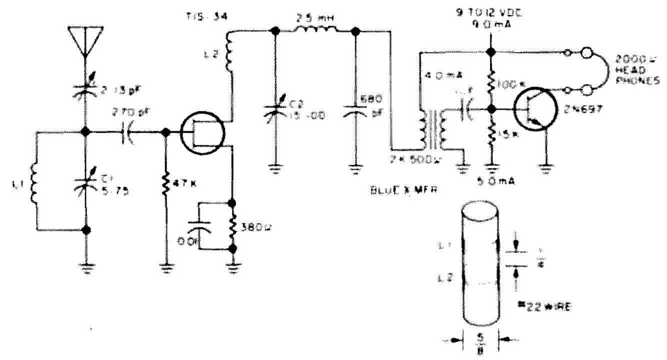

Fig. 2. Circuit which evolved from an old-two-tube "blooper" from 1932.

band out of business. Not only that, but the receiver will radiate a pretty healthy signal itself, which can be heard for three or four blocks.

What is its claim to fame? Well, it is a good project for the beginner in radio or transistors or FET's. It could also be fun on a pack trip into the wilds where P. G. & E. has not yet penetrated with its handy 60 hz wall outlets.

I use it in the 3.5 to 6.0 mhz band. It can certainly go much higher. With a TIS-34 it would work well on 10 meters. Above 10 meters, where CW and SSB signals are not too common, the super-regenerative design becomes more attractive.

Almost any sort of audio amplifier can be used depending on what you have available and whether you want earphone, loud speaker or both modes of reception. What I actually did was to use the rear end of a smashed up transistor broadcast set (my teenage daughter dropped it on the cement). If you have a choice, pick one with a push-pull class AB2 audio. These only draw current when audio signals are driving them and a significant saving in battery power will result. This is a good thing to remember when buying a transistor receiver for broadcast use as well.

In modifying the circuit to operate at higher frequencies, first resonate the tuned circuit (gate circuit) to the desired range. Then add the feedback winding using about 1/5 as many turns as in the gate circuit. You will find that it takes less capacity to obtain oscillation as you go higher in frequency. To get the detector to oscillate, increase the capacity of C3 (plates meshed). If that statement seems odd, you have just joined the club, friend. That is the way it wants to work. If you use a grid dip meter to check the frequency of C1L1, pull the transistor out of its socket first. You won't harm the transistor with a dip meter, but you won't see any dip either.

The TIS-34 is biased to Idss divided by 3. I picked that number out of thin air (sort of halfway between a class-A amplifier and a mixer), but it works so well that I have never tried varying it. The actual drain-source current for this particular TIS-34 is 4.0 ma (when oscillating). The audio amplifier draws 5.0 ma.

TIS-34's only cost a dollar but they are sometimes hard to locate. Hence I will mention that the MPF-105 or the TIM-12 can be used as substitutes.

Referring to **Fig. 1** you will note that there is no forward bias to speak of on Q1. Also note the total amount of series resistance in the collector circuit including the regeneration control. There is 80k in the fixed resistor plus another 20 or 30k in the regeneration potential.

Compare the series resistance in the drain circuit of **Fig. 2.** All you will find is the dc resistance of the interstage transformer T1 which measures 100 ohms in the model in use here. The current through Q1 is really limited only by the 380Ω bias resistor. The reader could vary this bias for optimum results if he cares to experiment. I don't recall ever seeing any equations for the gain of a regenerative detector. However, I do recall that when we replaced the resistance-coupled audio amplifier in the old two-tube blooper with an impedance-coupled (audio choke) amplifier, the signals in the earphones got considerably louder. That, in essence, is one main reason for the improved performance of the circuit in **Fig. 2.** The other main difference is the improved stability and overload characteristics derived from using the FET in place of the bipolar detector.

The push-pull audio amplifier (**Fig. 3**) was built as an outboard unit and not as a part of

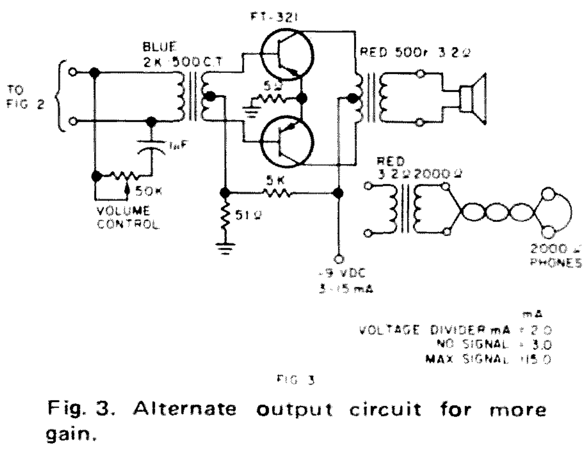

Fig. 3. Alternate output circuit for more gain.

the basic receiver (Fig. 2). The intention was to use it as a utility amplifier around the shack as well as with the basic receiver when loud speaker operation was desired. Almost all of the parts, including transformers, transistors and speaker, were taken directly from the smashed broadcast receiver. The one noteworthy addition is the volume control, and that is a W6OSA original as far as I know.* It had to be put where it is instead of in the usual place (in front of the first audio stage) because otherwise it would interact with the regeneration control. Not only is it smooth and noiseless in operation but the combination of the linear potentiometer and the 1 uf capacitor produced an audio taper effect.

The transistors in the Japanese portable happened to be PNP's. The Japanese number is FT-321 if that means anything to anybody. Actually you can use any PNP audio transistor such as the 2N188A. You can also use NPN's. Just reverse the battery and adjust the voltage divider to provide a slightly higher bias (if Si's).

As an added embellishment, I connected my favorite 0-15 ma meter in series with the audio amplifier battery lead. It works almost like an S-meter, and my son can watch the needle go up and down as he tunes in stations. This proved to be a mistake. Now he won't give the meter back.

After I had the basic receiver playing through the loud speaker, it occurred to me that it would be nice to have some extra gain plus a gain control available when listening with the headphones. So I kluged up the alternate output circuit shown in (Fig. 3). The transformer is a red output transformer, single ended type, from another defunct transistor radio. I think I can guarantee that once you have tried it this way you won't go back to using the headphones with the barefoot receiver. This being the case you might wish to incorporate the push-pull audio in the basic receiver. I still prefer the outboard arrangement because I envision using the amplifier for utility purposes, subject of course to the whims of number two son.

. . . W6OSA

*That's what I thought at the time. Later I ran across an almost identical circuit in a back issue of *73*, ("A Two Meter Transceiver," I1SLO, *73*, July, 1965, Pg. 8.). I wonder how I1SLO got Q18 to work with no dc return for its base?

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Multi-Channel FM Operation

Over the past few years, hams interested in local work on the vhf bands have been turning more and more to the use of surplus FM equipment. There is one great drawback to the use of this equipment. Generally it is crystal controlled on only one frequency at a time. This means that in an area such as mine (Seattle-Puget Sound), a person wishing to enjoy all the available activity would have to be continually changing crystals.

At home, with the base station, this would not present too much of a problem. You open the equipment, unplug one crystal and plug in another. However, it is another story if you happen to be driving down the freeway at 65 per. The question is, how do you change frequency remotely while mobiling?

The answer to the previous question is not by any means new. It is, in fact, used by some manufacturers of equipment. However, it is little known and used among the amateur fraternity. Many mobileers wish that they could add a second channel to their equipment. At times this is desired to the extent that high priced equipment is purchased because it contains this feature.

Many miniature DPDT relays are collecting dust in surplus stores around the country. These relays are about the size of a standard crystal; hence they are named "crystal-can Relays." The only drawback to the use of these relays, and the reason that they are gathering dust, is that the coil is rated at 28 vdc. This is but a minor thing at most. Experience has shown that even though they are rated at 28 vdc they will operate fine at 12 vdc. At last, for the mobileer, the problem is solved (unless of course he happens to be one of the few driving a car with a 6 volt electrical system).

If you were to look up these relays in an industrial catalog, you would shy away from the $18-$20 price tag. These relays, while not quite flooding the surplus market, are available at $0.35 to $1 each.

The operation is quite simple for dual channel operation in equipment such as a Motorola 5v or the like. For commercial service, most of this equipment came with a socket that accommodates the crystal as well as an oven to keep the crystal temperature stable. This socket will hold 2 crystals. The only thing necessary is to remove all four wires from the socket, install the relay wiring one side of the relay to one side of the socket and the other to the remaining contacts. All that is left is to hook up the supply to the coil and run a wire to the control head.

It is best to key the relay to ground and at the same time install a light to let you know which channel you are on currently.

One other item of importance to the conversion is the use of correlated crystals in the oscillator. This modification can be made without sacrificing on-frequency operation if this precaution is taken.

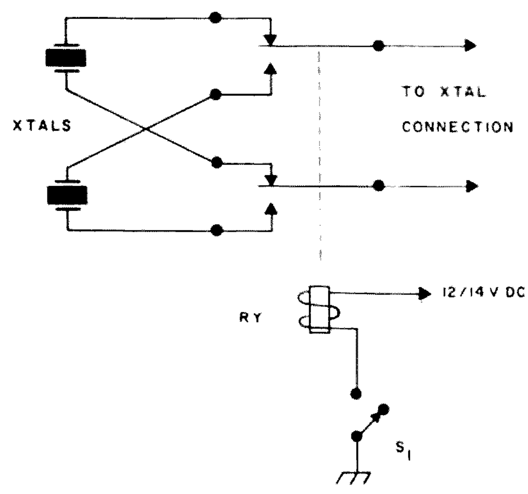

Fig. 1. Switching two crystals.

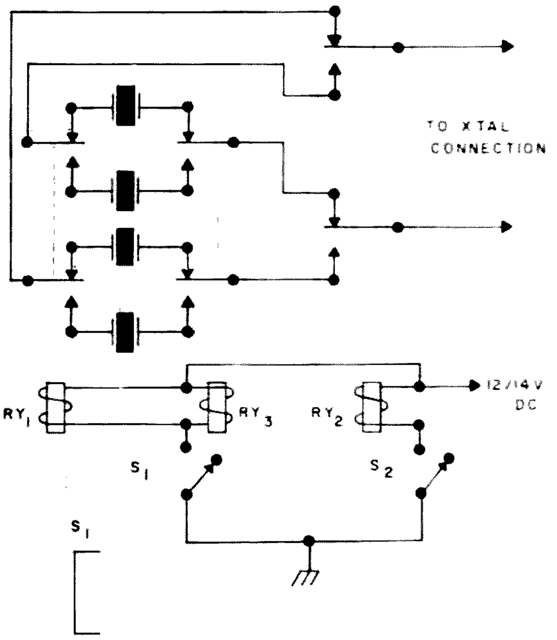

Fig. 2. Switching four crystals.

I have seen this done many times, even with the crystals ordered over a year apart.

The dual channel unit is simplicity in itself. Closing the switch actuates the movable arm of the relay. These arms are connected to the original wires going to the crystal socket.

With the relay inserted, the additional inductance and capacitance may necessitate a small adjustment of the oscillator padder. However, if correlated crystals are in use, the adjustment should be the same for both channels.

On the four channel unit, two relays are used to switch between crystals, and a third to switch between the outputs of the two relays.

Admittedly the system as shown would not allow cross channel operation, but this is not feasible in a mobile installation. On a base unit, this is a different story, though this is going a little beyond the intended scope of this article. Suffice to say that it can be done with little extra effort.

This is the easy way to do the crystal waltz. There are more complicated systems, and all I can say for this one is that it works with a great degree of reliability.

One final word in passing; if good vhf practices are employed, no problems should be encountered.

Be seeing you on multi-channel operation soon.

. . . WA7EVX/Ø

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The Case for the 5/8 λ Vertical

In fixed-station usage and particularly for VHF mobile use, the 5/8 λ vertical has various advantages over a 1/4 λ vertical or whip. The advantages are discussed and a simplified matching system is presented.

Many amateurs use quarter-wave verticals in both fixed-station and mobile use because of the low radiation angle and constructional advantages that they possess combined with a direct match to a coaxial transmission line. Not every situation will allow extension of the antenna length to approximately twice its quarter-wave length, but, if it can be done, additional gain can be achieved and matching the 5/8 λ vertical to a coaxial transmission line need not be complicated. In a vhf mobile situation, even a construction advantage will be achieved since, as is discussed fully later, the 5/8 λ vertical mounted in the same position as the regular automobile radio antenna will equal or outperform an awkward to mount roof-top quarter-wave whip.

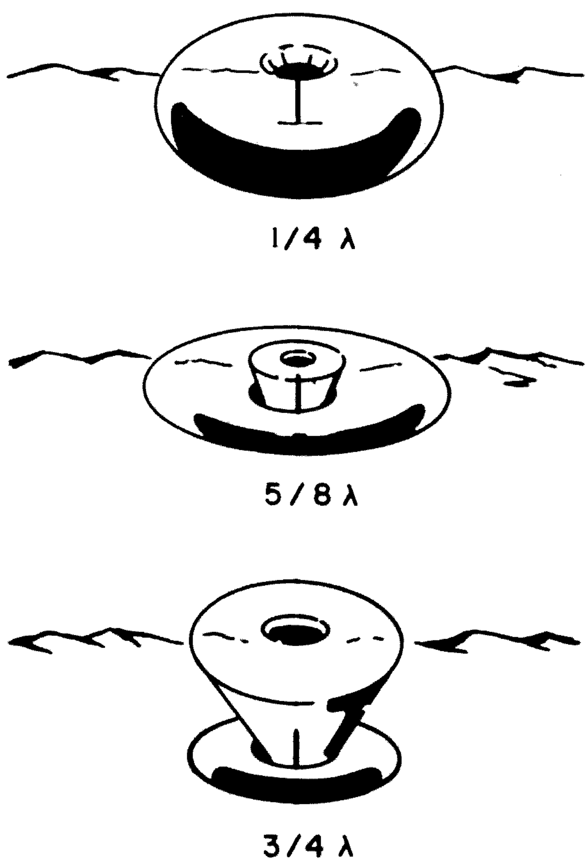

Fig. 1. Pictorial representations of the radiation pattern of various length vertical antennas over a perfect ground.

Why a 5/8 λ long antenna should show a "gain" over a 1/4 λ long antenna while both antennas still exhibit omnidirectional radiation patterns is a subject that many amateurs still find somewhat confusing. So, a brief explanation of vertical antenna gain might be in order.

Gain of Vertical Antennas

The word "gain" itself is often misused with respect to antenna systems. It is defined as the relative amplitude of the maximum radiation from an antenna as compared to the maximum radiation from a reference antenna. The key points are that the maximum radiation determines the gain figure and the figure can vary widely depending upon what antenna is used for a reference antenna. Whether the maximum radiation takes place in a direction or at an angle that is useful in a given communications situation is another question. It is quite possible that an antenna with a higher gain figure will perform poorer than an antenna with a lower gain figure.

A half-wave horizontal dipole is frequently quoted as the reference antenna for directive antennas, such as beams, quads, etc. However, it is not the most basic reference antenna used and is a particularly awkward one to use when speaking of the gain of a vertical antenna. The most basic antenna used is a so-called isotropic radiator. Such an antenna does not exist in reality, but in theory it is an antenna in free space which radiates equally in all directions (its radiation pattern is a perfect sphere which surrounds the antenna).

If one now looks at the radiation patterns

shown in Fig. 1 for various vertical antennas, it should be clear why these antennas have gain as compared to an isotropic antenna. If the same input power is used for the isotropic antenna and the vertical antennas, and all the antennas radiate all the power fed into them, the vertical antennas must radiate more energy in some directions than the isotropic radiator in order to account for all the power fed into the antenna.

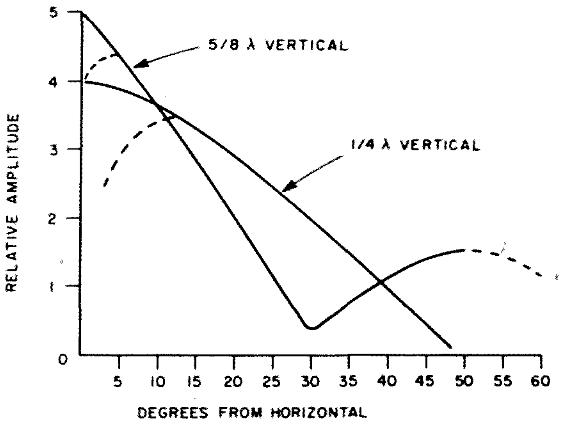

Fig. 2. Graphic representation of the vertical radiation pattern from 1/4 and 5/8 λ verticals. The dotted lines show the approximate effect of ground losses.

Compared to an isotropic radiator, the direction of maximum radiation from a 1/4 λ antenna shows a gain of about 1.6db and that from a 5/8 λ vertical is about 2.5db. Fig. 2 may provide a clearer illustration of the maximum radiation from the 1/4 and 5/8 λ verticals. The figure shows relative field strength versus the radiation angle measured from the ground plane surface. The 1/4 λ vertical presents a single, constantly decreasing radiation amplitude as the radiation angle increases. The 5/8 λ vertical presents also a constantly decreasing radiation amplitude; however, with a relatively greater amplitude at the extreme low radiation angles and with a secondary peak centered around 50°. If the graph included the 3/4 λ vertical, it would show approximately, the relative amplitudes of the low angle radiation and 50° radiation from the 5/8 λ vertical interchanged. High angle radiation takes place from the 3/4 λ vertical because the currents in various sections of the directly extended antenna do not reinforce each other such as to keep the radiation angle low. By means of phasing networks, it is entirely possible to build a vertical antenna many wavelengths

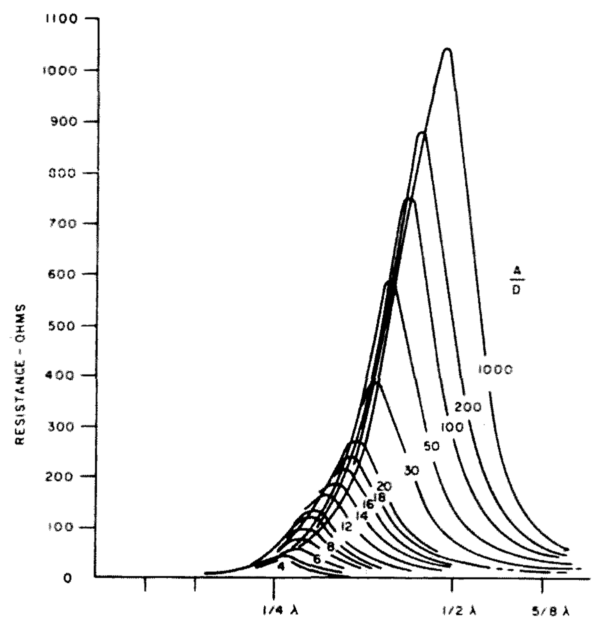

Fig. 3. Vertical antenna terminal resistance as a function of length. A/D is the ratio of antenna length to antenna diameter (d).

high but with extremely low angle radiation. One prime example of such an antenna is a commercial uhf-TV transmitting antenna built by RCA. The horizontal radiation pattern from this antenna is omnidirectional, but yet it has a 60 db gain because all the radiation is concentrated within an extremely narrow band around 1 .

Ground Effect

The solid lines in Fig. 2 represent the radiation that takes place with a perfect ground surface. This condition can be approached fairly well on the vhf bands where the antenna is placed over a large metal surface, such as an automobile body. However, it is rarely the case on the high-frequency bands unless an extensive ground radial system is used. The dotted lines in Fig. 2 represent the loss which takes place in extreme low angle radiation over a fair to poor ground surface.

An interesting point to note is that, although both the 1/4 λ and 5/8 λ verticals suffer considerable low radiation angle losses, for the 5/8 λ vertical it is not so severe at the low angles below 5°. For DX operation where one-hop F layer propagation is used, the 5/8 λ vertical usually shows an apparent gain over a 1/4 λ vertical that is considerably greater than the approximate 1db difference theoretically indicated.

Matching to the 5/8 λ vertical.

Although the increase in antenna height from 1/4 λ to 5/8 λ, where feasible, probably represents one of the least expensive ways to gain effective db's either for long-haul DX or extended ground wave coverage on the vhf bands, many amateurs are hesitant to try this approach because a 5/8 λ vertical does not directly match a coaxial transmission line. However, it is quite simple to match the antenna to a coaxial line for single band operation without the need for an antenna coupler or any expensive components.

Fig. 3 represents the terminal or base re-

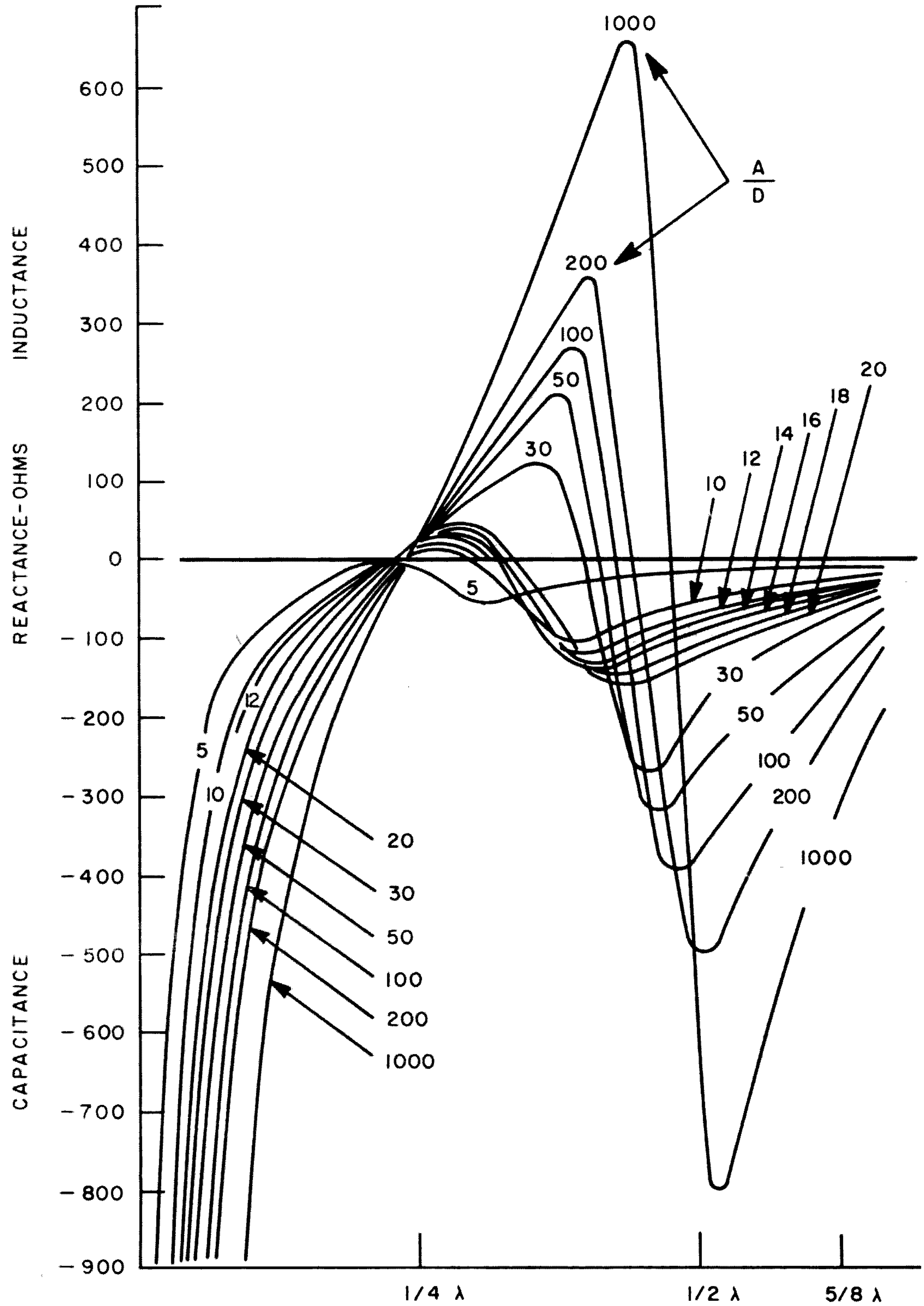

Fig. 4. Terminal reactance of a vertical antenna as a function of its length. A/D is the length/diameter ratio, both expressed in the same units.

sistance of a vertical antenna while Fig. 4 shows the reactive part of the base impedance. These graphs may appear somewhat complicated but lead to a very simple matching means for a 5/8 λ vertical (or for most other length verticals as well). The graphs are drawn for various A/D ratios. (Antenna length divided by antenna element diameter).

An example should make the use of the graphs clear. Suppose that it is desired to use a 5/8 λ vertical (of about 52" long) on 2 meters which is constructed of tubing having a 4 mm. diameter (which would be the typical average diameter for a telescoping automobile whip). This results in an A/D of about 200-250. From Fig. 3 it can be seen that the resistive portion of the vertical's impedance is about 60 ohms and could present an almost perfect match to a 52-ohm coaxial cable. From Fig. 4, the reactance is noted as being 180 ohms capacitive. Once this reactance is cancelled, therefore, an excellent match to the transmission line will result.

There are several ways by which the capacitive resistance can be cancelled. One of the simplest ways is shown in Fig. 5. A shorted coaxial stub is connected to the base of the antenna and its length chosen to present an inductive reactance that just cancels the antennas capacitive reactance.

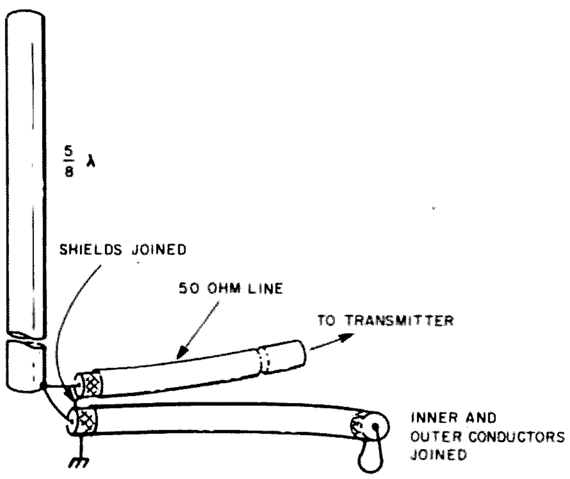

Fig. 5. Use of stub to match a coaxial line to a 5/8 λ vertical. Length of stub can be calculated or determined by experiment, as explained in text.

Determining the length of the stub can be done either by cut-and-try or by formula. For those who don't mind wasting a bit of coaxial cable, the cut-and-try procedure involves simply making the stub initially 1/4 λ long at the operating frequency and with an swr meter in the transmitter coaxial line at the antenna base, cutting back the stub until unity swr is achieved. Note that every time the stub is cut back, the inner conductor and outer shield must be shorted together. The starting length of the stub would be, in inches, $\frac{2808}{f\ (mc.)}$ x V. V is the velocity of the coaxial cable used, usually about .66.

The stub length can be determined by formula to a very good degree of accurracy by the formula: L stub inches = $\frac{32.8\ VL}{f\ (mc.)}$.

V is again the velocity factor and L is an angle whose tangent is the value of inductive reactance desired divided by the impedance of the cable used for the stub. For example, for the 2 meter vertical L would be (using a 52 ohm cable for the stub) $\tan \frac{180}{52} = 3.6 \cong 75°$

Placing this value in the formula would yield

$$L = \frac{32.8\ (.66)\ (75)}{144} = 11\frac{1}{4}\text{" stub length.}$$

If one desired to use an actual coil instead of a stub, the required inductance, in microhenries, would be

$$L = \frac{X_L}{6.28\ (f\ mc)} = \frac{180}{6.28\ (144)} = .2\ \text{rh}$$

A coil of this value can be formed but unless one has the equipment to measure its inductance fairly well, the stub method of matching will be found to be far simpler and quicker.

Mobile Application

The 5/8 λ vertical is useful in any situation where the greatest amount of omnidirectional low angle radiation is desired without resorting to a complicated antenna structure. However, for mobile applications on the vhf bands, the 5/8 λ vertical has particular appeal.

It can be mounted on the automobile in the same location as the regular automobile whip. In fact, it can be constructed from any ordinary telescoping automobile antenna since its length would be about 52" on 2 meters. The sections of the automobile whip should be soldered together at the telescoping joints to insure good electrical contact. Fig. 6 shows a comparison of the radiated field from a 1/4 λ whip mounted directly in the center of the csr roof and that of a 5/8 λ vertical mounted in the same position as the regular automobile radio antenna. The 5/8

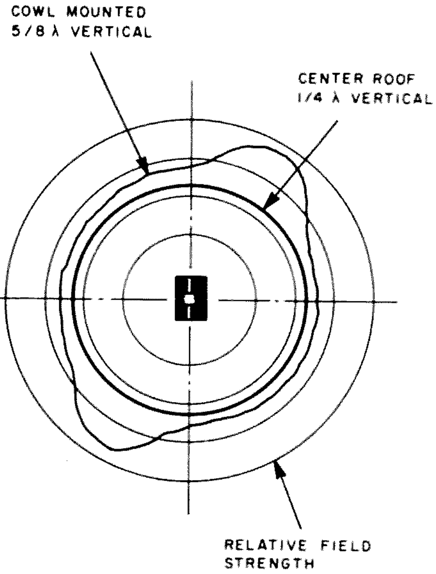

Fig. 6. Tests by many manufacturers have shown that a simple to mount 5/8 λ cowl antenna will equal or outperform a roof mounted 1/4 λ antenna.

λ vertical is never worse than the very-awkward-to-mount 1/4 λ vertical and shows usable gain over the 1/4 λ whip over a fairly broad portion of its pattern.

Other advantages of the 5/8 λ vertical are that it offers a much closer match to a 52-ohm coaxial cable than a 1/4 λ vertical and its bandwidth is broader. The latter results due to the stub matching system since the reactance of the antenna and the stub change in opposite directions (but at different rates) with changes in frequency. At least until the rate change becomes excessive, this means that the reactance cancel each other and the swr will remain very low over almost any band when the antenna is designed for the band mid-frequency.

Summary

The 5/8 λ vertical offers one of the simplest ways to extend the performance of a vertical antenna system where low-angle radiation is desired. On the high-frequency bands for DX purposes, the real gain from such an antenna can far exceed the expected gain since it seems not to suffer the severe loss of extreme low angle radiation that occurs with a more ground "dependent" 1/4 λ vertical.

On the vhf bands for mobile situation, it offers wide bandwidth performance combined with a simple and inconspicuous installation.

...W2EEY/1

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The Genesis of Radio Reception

Recently, in one of the larger electronics stores, my eye was caught by the advertising blurb on the box containing a crystal receiver kit, "using the same circuits used by Marconi. . . ." It struck me as being a rather bold sucker attraction, since the crystal detector didn't really get going for at least a couple of decades after Marconi's history-making transmission.

Strange though it may seem, Marconi was by no means the first experimenter in wireless communications, though he was the first to use radio waves over a great distance. Morse, for instance, had a system for sending telegraph signals across a stream or canal without using wires. Morse used several hundred feet of wire running along each side of the stream which ended in a metal plate submerged in the water. Electric impulses were carried through the water from the system on one side to the other. It had its disadvantages. In order to get any kind of efficiency from the system, the two plates on one side of the stream had to be further apart than the distance between systems. As a result, more wire was used to do it that way than if the stream had been spanned.

In England they had an even clumsier set-up. A complete loop was set up on each side of the stream, parallel to one another. The current in one loop, coming through an interruptor, would magnetically induce currents in the companion loop and make a sound in an earphone. This procedure again used more wire than necessary to span the stream, and so was impractical.

Edison had a patent granted on a system in which electrostatic charges in a large tower would induce similar charges in a similar tower on a ship at sea. This was fine for very short distance transmission, but as the distance increased, it quickly became useless. It did, however, give Edison one advantage. He had patent rights on the aerial, and Marconi paid a pretty price for it.

Hertz's discovery of "radio" waves had no real kind of detection device. He simply discharged a Leyden jar through a metal ring. A ring of similar size would produce a spark. This also was not effective over long distances.

In the early 1890's, a scientist by the name of Branly noticed that a distant spark would affect metal filings. Loosely packed filings normally showed a fairly high resistance, but whenever an electric spark was produced in the same area, the filings would stick together and the resistance would be momentarily reduced. Lightning and other discharges could be detected by a click in a pair of headphones connected to the "coherer" through a secondary battery. In 1894 Oliver Lodge conceived the idea of using a coherer to detect the mysterious waves noted by Hertz. Lodge, however, was

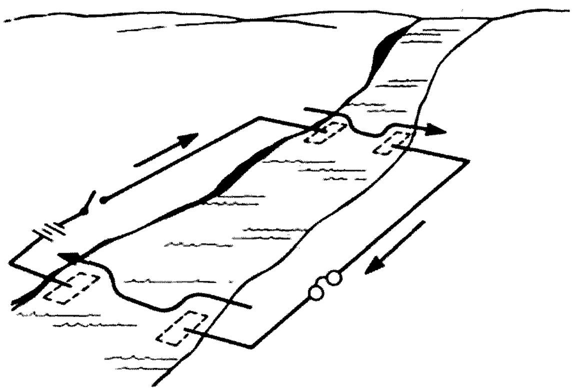

Fig.I. Morse's system of wireless communication using a river as the conductor. Arrows show the hoped-for path of the current.

not working in communication. He was experimenting in the field of electromagnetism, so he never patented his idea. About that time, Marconi entered the picture.

By applying Lodge's idea, and adding an antenna and ground circuit, Marconi was able to transmit for several miles. Marconi's first receiver used a coherer for a detector, coupled to a tuning system invented by Lodge. His first attempts were so successful that he had little trouble getting the backing necessary to form the British Marconi Wireless Telegraph Co. Before long, however, he abandoned the coherer for a system of his own invention (with considerable help from Lodge and Fleming, two top physicists of that day). This consisted basically of a transformer, the primary winding of which was in the antenna-ground circuit. The secondary was connected directly to the earphone. Perhaps the most interesting part of this was the core of the transformer, which was an endless iron belt. This belt was kept moving through the transformer. A pair of large permament magnets kept the core continually magnetized in one direction. This might possibly have caused some sort of a rectifying action, since currents in a direction favoring the magnetic flux of the

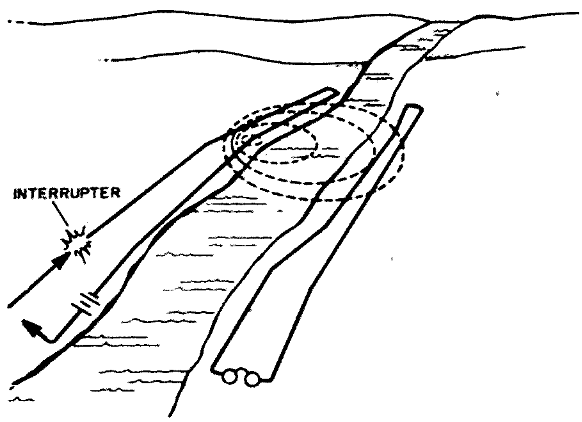

Fig.2. Magnetic induction method of wireless communication. Magnetic flux from transmitting loop induced currents in receiving loop.

core could transfer more easily than the other half cycle. But spark transmitters were rough enough so that I doubt if it were really necessary to rectify the signals at all.

Some two decades prior to this, Edison had been experimenting with various types of incandescent lamps and stumbled across thermionic emission. He failed to see its significance, however, and just jotted the discovery down in his notebook, and then forgot it. Years after, Ambrose Fleming was to apply this effect and patent the vacuum diode, or, as he called it, the Fleming valve. Fleming was, at the time, working for Marconi, but Edison had an ace up his sleeve, since he owned patent rights on the Aerial, an important part of Marconi's system.

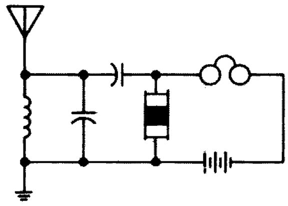

Fig.3. A possible arrangement of Marconi's coherer receiver. Signals selected by the tuner passed through the series capacitor into the coherer, where they momentarily decreased the resistance causing a click in the earphone.

Before Fleming's valve made the scene, however, another type of rectifier saw considerable use. This consisted of a platinum wire touching the surface in a dish of acid. If current tried to flow in the wrong direction, a bubble would appear beneath the wire and prevent conduction. This was called the "electrolytic rectifier." The scientist who invented this, Fessenden, came up with another idea which the reader will

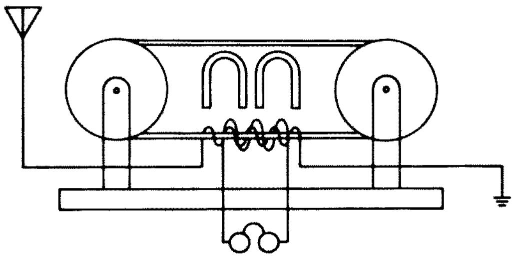

Fig.4. Marconi's magnetic detector. A soft iron magnetized belt was kept moving through the transformer.

be surprised to see hanging around this early in the game.

The idea was called the "hetrodyne," composed from two Greek words meaning "other, and "power." His idea was to use two high frequency signals which were inaudible but capable of traveling long distances. For instance, a 100 khz. signal could not be heard, but if, at the receiving end, a 101 khz. signal were injected at the same time, the combination would make a tone of 1 khz. He also planned to superimpose audible signals onto a carrier signal, the beginning of amplitude modulation, but

the transmitters of that day were not good enough to make his idea practical.

Marconi's company owned all rights on Fleming's valve and flatly refused to license it to any American companies. It was superior enough to render his competition ineffectual. In order to keep from going under, a competitive device had to be discovered. The answer came in the form of galena, carborundum, and other crystals which displayed rectifying qualities. The solid-state field was doomed to lie dormant for a long time, however, thanks to a man named DeForest. DeForest had been experimenting with Fleming's valve, trying to make it more efficient. He first wrapped the outside in foil, hoping to ionize the residual gasses inside and therefore cause it to conduct more efficiently. It didn't work too well at first, so DeForest put the foil inside the valve. The results were encouraging. He then made the foil into a perforated plate between the filament and anode. Finally he tried a fine wire *grid*. He had done it! The triode was born, and so was electronics.

The first triodes were so large they were called "bottles," and glowed so brightly they lit up the whole shack. At first they were kept highly secret. DeForest had his first model sealed up in a box with the leads sticking out. When he got it working, he let his assistant listen. "My God, doc, hear those signals!" he cried, "What in H . . . have you got in that box?" DeForest called his new device the Audion. He was able with little trouble, to sell his invention to the U. S. Navy, until some wise-guy technicians tried

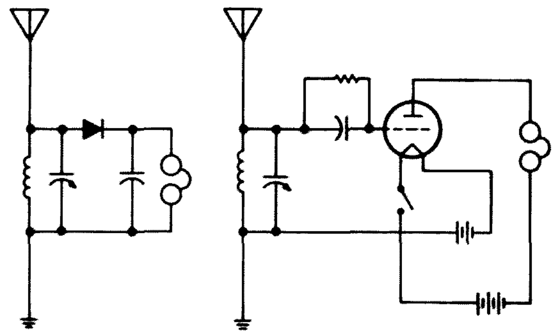

Fig.5. Basic circuit of the rectifier detector, and the audion grid-leak detector "My God, hear those signals . . . ."

to improve the results by running the filaments at a higher voltage and blew them out. The chief clerk, refusing to believe that Navy personnel could do any wrong, passed the order, "No more audions; use your old detectors." DeForest wasn't worried. He was going full speed on an invention that would revolutionize communications. After discovering the amplifying properties of the audion, he had collected nearly two million dollars from the telephone people (Western Electric) who desperately needed an amplifying device.

Meanwhile, DeForest had discovered how to make his audion oscillate and then how to modulate it. He was making daily music and news broadcasts over a decade before some hams licensed KDKA.

Sometime between 1910 and 1920, E. H. Armstrong began experimenting with DeForest's audion. He tried to make the tube amplify its own output. Feeding the signal back to the grid circuit through an additional winding connected to the plate, he discovered that the output level certainly did increase. Not only that, but if the signal was fed back in sufficient quantity, the circuit would oscillate. His hook-up was so similar to DeForest's oscillator circuit that a court case erupted and DeForest was awarded the patent. However, Armstrong had no patent trouble after that. His progress sent him in leaps and bounds far ahead of his competition.

His receiver was called the "regenerative detector," and was developed just before WW I. After the war, it was eagerly bought by the public. About the same time, the crystal detector became available to the public. Armstrong's regeneration however, was far ahead of the "Crystal sets" and regenerative receivers were so popular that their oscillations began to cause serious interference. Something had to be done. The problem was solved by adding a stage of tuner *rf* amplification which, in addition to increasing the sensitivity, isolated the oscillating circuit from the antenna. Browning-Drake put out a popular model around 1924-25.

To compete with Armstrong, Hazeltine came out with the "neutrodyne" circuit in the late 20's and early 30's. This consisted of a straight grid-leak detector preceded by several neutralized TRF stages. You can still find an occasional sample of these monsters in various attics and cellars. They are easily recognized by their many ganged variable capacitors. Hazeltine had another feature which, following the development of an even better receiver, was to help keep them in the communications picture. This was a technique of rectifying the signal and feeding it back as a negative voltage to the

grids of the amplifier stages. The result was that a more nearly constant output level was realized over a wide range of input levels. The technique was called "automatic volume control," or AVC. A more sophisticated version of the name is automatic gain control, AGC.

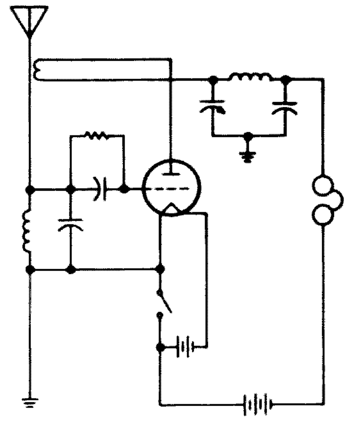

Fig.6. Armstrong added a feed-back winding to DeForest's audion detector introducing regeneration.

Another accomplishment of Armstrong's was the "super regenerative receiver." This circuit, designed for vhf work, was actually a regenerative detector which was switched in and out of oscillation at an ultrasonic rate. This allowed hitherto unheard of amplification, a quality badly needed in the vhf range.

During WW I there was developed a revolutionary circuit which, upon its reaching public hands, was to render all the previous circuits obsolete. I can remember seeing an ancient issue of *QST* in which the ARRL vehemently denounced the new "superhetrodyne" receivers because of a rather disturbing characteristic. The circuit used Fessenden's old hetrodyne technique with a new twist. The oncoming signal would

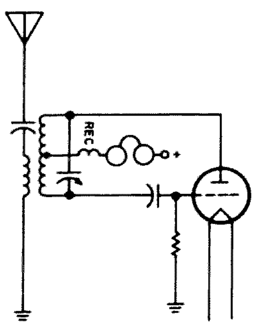

Fig.7. The Super-regenerative Detector (now outlawed because of radiation).

be mixed with an internal signal to produce a new signal, *still at radio frequencies,* which would be amplified through several tuned stages before being detected. This new frequency, called the intermediate frequency, was quite low, around 175 khz., so the tuned *IF* stages achieved a far better selectivity than ever before. The superhetrodyne was far superior to any other receiver circuits except for one thing. There were *two* possible incoming signals which could produce the same intermediate frequency. Therefore it would be possible for amateur stations to be picked up by this circuit when it was tuned to another frequency, and it would not be the fault of the amateur station – hence the ARRL's objection. The superhet was accepted anyway, and, except for owning the patent for AGC, Hazeltine would have been out of business.

Armstrong's line was done for, too, except for experimenter kits and circuits in the Boy Scout Merit Badge Book. Armstrong wasn't so bad off, however, for he had just come up with another new technique. He called it "frequency modulation," and it goes on and on and on. . . .

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An Introduction to Integrated Circuits

There are already two main types of integrated circuits. These are digital and the type that will be discussed here, linear. Digital IC's are used mainly in computer technology using their switching characteristics. Other circuits such as amplifiers, oscillators, etc., require more than the on-off of digital IC's and are thus more complex.

IC Construction

There are two types of IC's, monolithic and hybrid. Monolithic circuits are made on one slice of semiconductor whereas hybrid circuits are small "thin film" circuits wired together on the substrate material.

Monolithic IC's are made in a similar way to the diffusion process in transistors. (See "Basic Theory and Applications of Transistors" by same author.) In IC's this process is called silicon planar technology. Just as in a transistor, the IC begins as a small wafer of silicon (either N or P type). Impurities are added to either make the material N or P. When the process is completed, an insulatory oxide is palted over it. This coating is broken in at certain locations to permit the fastening of metallic leads to the different areas. When this process is completed, a simple NPN transistor is formed. (See **Fig. 1**)

This process may be carried out again inside the previously formed area so that two single transistors may be formed. (See **Fig. 2**)

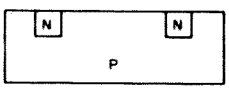

Fig. 1. Single NPN transistor formed on p material.

When an internal resistor is required in the circuit, pieces of resistance wire are imbedded in a P-type region. The total resistance is $R_T = R_S \times 1/W$, where R_S is the pre-determined sheet resistance and W is the width of the material. Therefore, the more narrow the actual resistor, the larger the resistance.

A thin film resistor is formed by depositing some resistive material such as nitrided tantalum, nichrome, or tin oxide over the SO_2, covering the P-type substrate. The resistance may be found by $R_{AB} = 1/dW$.

When a high value resistor is needed and the length is not available, a zig-zag pattern may be used.

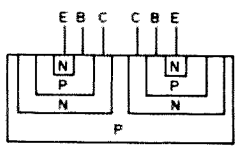

Fig. 2. Double IC transistors formed on one slice of p material.

Capacitors may also be formed on IC's. By using the oxide as a dielectric and N-type material as the other lead, an IC capacitor is formed in the same manner as its big brother. The value of the capacitor is found by $C = A \times E/d$, where A is the area, E is the dielectric constant and d is the thickness of the oxide. This capacitor has the disadvantage of having a small capacity and a variance in values with a change in the collector to base voltage.

Inductors in IC's are usually connected ex-

ternally for the values which may be miniaturized are very small.

Comparisons of IC and "Normal" Components

Values of IC resistors are very critical when they are made. Unlike the normal resistor which depends upon the resistivity of the carbon material contained, the IC resistor's value is determined solely by its geometrical form. The resistors values vary greatly with a change in temperature and so they are designed to operate by ratio rather than by exact value.

The major difference between regular transistors and IC transistors is that IC transistors have less capacitance.

One of the main advantages of IC transistors is that since they are fabricated from the same material under the same conditions, they are very closely matched in their characteristics. When there is a change in temperature, it affects all transistors equally because of their proximity.

Basic IC Circuits in General

One of the best uses of the IC is in a balanced differential amplifier. This amplifier requires few resistors and capacitors and has excellent isolation of output to input thus reducing feedback.

An operational amplifier is a very high gain amplifier which uses its feedback for control. This amplifier may be used in many ways and is the most versatile circuit of the IC's.

Arrays

Arrays of diodes and transistors in IC's have the advantage of all being constructed from the same material and thus all being closely matched. This is useful when a careful balance must be made in circuits such as bridge rectifier and balanced modulators. The diodes are formed by shorting out the appropriate leads from the IC transistors. (See Fig. 3.)

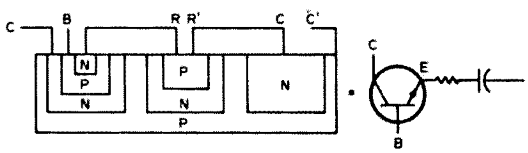

Fig. 3. Simple monolithic IC and its equivalent circuit.

DC Power Supply

The supply voltage to IC's, as in transistors, is around 15 to 35 volts dc. If the polarity is reversed, again as in transistors, excessive current will flow and destroy the junctions. Stray inductance may be eliminated through the use of feed-thru capacitors properly grounded. If this inductance is not eliminated, it will build up and eventually cause a high voltage to flow through the IC. This affect must be compensated for by the use of a voltage shifting circuit which will make the input and the output algebraic sum equal to zero.

Packaging Techniques

There are three main types of packaging now used in the manufacture of IC's. These are the traditional TO-5 transistor metal can, the ceramic flat pack, and the dual-in-line package. The TO-5 package may have 8, 10, or 12 leads. The flat packs and the dual-in-line usually have 14. Although the ceramic packaging is the most efficient (having the best electrical and heat characteristics), it is most expensive to produce. The most practical and widely used package is the plastic-molded. Although it doesn't have the best heat characteristics, it is the cheapest, easiest and most versatile of the many packages available for IC's. (See Figs. 4 & 5.)

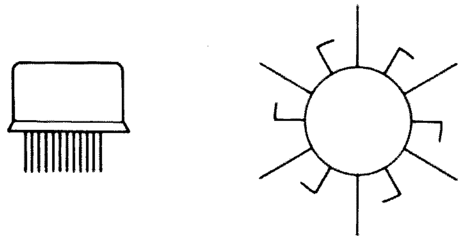
Fig. 4. TO-5 case and off-set bending of leads.

Mounting Procedures

There are several methods of mounting IC's. Like all semi-conductor devices, IC's are heat sensitive at their leads. The TO-5 cases may either be mounted in commercially manufactured sockets (similar to transistor sockets) or directly soldered to the circuit board. The socket is particularly useful when an experimental circuit is set up and many IC's have to be substituted into the circuit.

As previously mentioned, the TO-5 case may be mounted directly to the board. There are several ways of doing this; one way is to simply drill holes in the board in the same pattern as the base and bringing the leads to the appropriate places in the circuit.

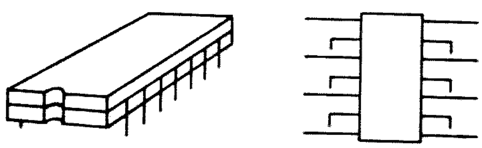
Fig. 5. Dual in-line and off-setting of leads.

If the circuit is crowded around the IC, the off-set method may be used. This is a method in which every other lead of the IC is bent downward so that the leads may be evenly distributed around and outward. (See Fig. 4.)

The flat packs and the dual-in-line are mounted in a similar way in that they may be mounted directly or off-set. (See Fig. 5.)

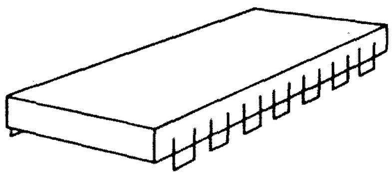

Fig. 6. Molded plastic package.

General Integrated Circuits

The balanced differential amplifier is the basis for most linear IC's. As shown in Fig. 6A, the circuit basically consists of two integrated circuit transistors which operate in a similar way to a circuit with two NPN transistors.

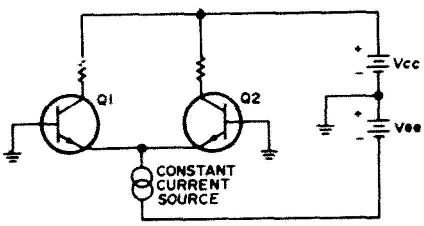

Fig. 6A. Balanced differential amplifier.

General Purpose IC's

For a start of basic integrated circuits, let us begin with the commonly used dc amplifier, as the RCA CA 3000. This circuit is basically a single-stage differential amplifier (Q_2, Q_4) with input emitter-followers (Q_1, Q_5) and a constant current sink (Q_3). The char-

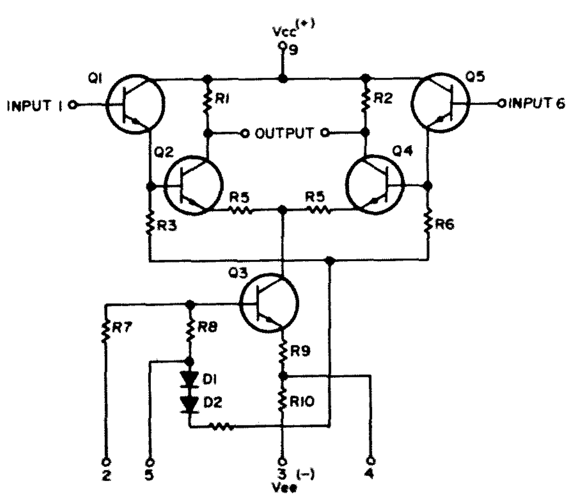

Fig. 7. CA 3000 dc amplifier.

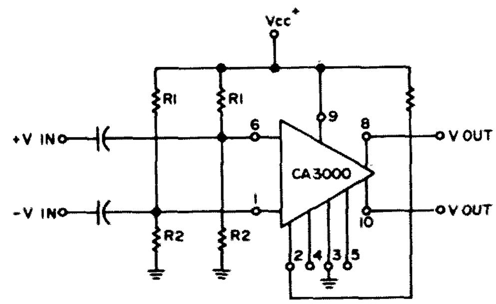

Fig. 8. CA 3000 with a single voltage supply.

acteristics of this amp. include a push-pull input and output. (See Fig. 7.)

This circuit is provided with an external means of changing the emitter resistor of Q_3 by shorting out terminals 3-4-5 to suit the user.

Characteristics of the CA 3000 vary from V_{cc} = .4, $-V_{ee}$ = -3 with a 16.6 db gain to V_{cc} = 5, $-V_{ee}$ = -6 with a 32.4 db gain.

The CA 3000 may be used in many applications useful to the amateur such as a crystal oscillator, modulator or a mixer.

The CA 3000 may be used as a crystal controlled oscillator up to 1 mhz in its standard form. Using variable feed-back cleans up the signal by smoothing it out. (See Fig. 9.)

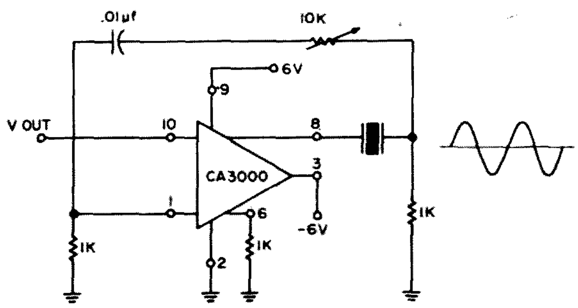

Fig. 9. CA 3000 crystal oscillator with variable feedback.

The CA 3000 may be used as a modulated oscillator by feeding a 1 khz signal into terminal 2 and using a high pass filter at the output. (See Fig. 10.) The CA 3000 is used in a similar way by feeding the signal in 1 or 6 and 2 or 5.

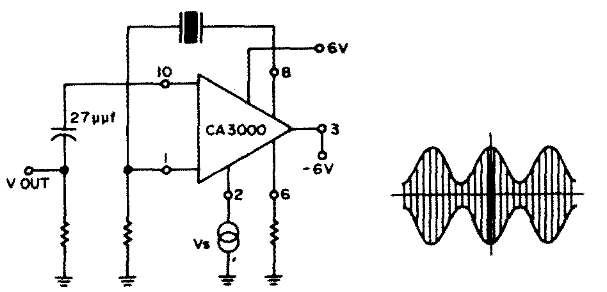

Fig. 10. CA 3000 modulated oscillator.

From this point on, for simplicity's sake, IC's will be treated like black boxes whose circuits are too complex to explain within the scope of this article. When designing is being done, only the function and the parameters are necessary.

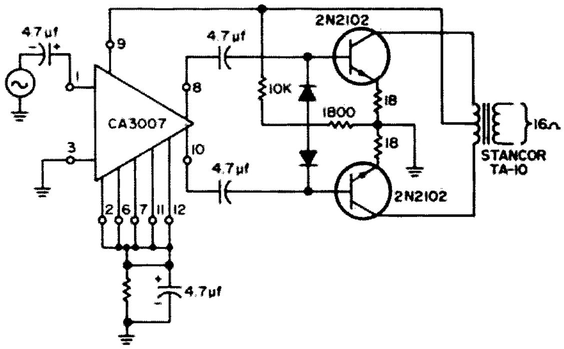

Fig. 11. CA 3007 used in a 30 mw. audio amplifier.

The CA 3007 is a basic IC audio driver. Fig. 11 shows a simple, practical, single supply audio amplifier. The CA 3007 has the capability of 24 db gain with a power dissipation of 20 mw.

Even wide band amplifiers have been replaced by IC's. Such an IC is the CA 3001 shown in Fig. 12. This circuit may be used as a video modulator with typical characteristics of up to 106 mw dissipation with 17.8 db with 6V and 2.8V power supplies. This circuit may easily be taken advantage of for use in the ATV station where amateurs have stayed away from video circuits because of their complexities. There are several other video IC available for similar purposes.

The IC which should have the most appeal to the amateur are the *rf* amplifiers which are the CA 3004, CA 3005, CA 3006 and the CA 3028A. These circuits are designed to operate in the range of dc to 120 mhz. A few of the many uses of this IC are amplification, mixing and frequency generation. These four IC's may be used with external circuits to obtain many other circuits.

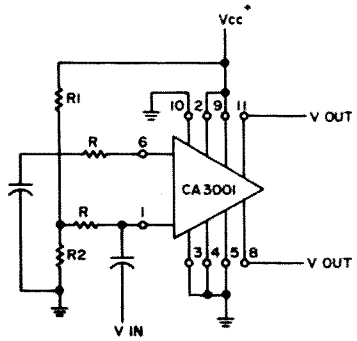

Fig. 12. Circuit connections of a CA 3001 for a single supply.

One typical use of the CA 3005 or CA 3006 is in a double sideband suppressed carrier modulator circuit. (See Fig. 13.) This circuit should have great appeal for amateurs for it may be used as the backbone of a DSB system. For more specific applications and data consult the RCA IC handbook.

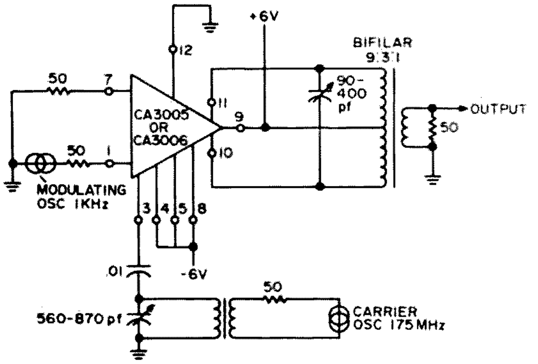

Fig. 13. Double sideband, suppressed carrier modulator using the CA 3005 or CA 3006.

Conclusion

As shown, the use of IC's today is almost limitless for both the "amateur" and the professional. For the professional, the advantages are numerous. IC's are useful where space is valuable and there is not room for conventional circuits. Also, since most of the circuit is built in, a great amount of time is saved in construction. For servicing, the IC cannot be beat. Although if one part burns out, the whole circuit goes, the defective IC is fairly easy to locate and replace.

IC's also have many advantages for the amateur. For those who fear transistor circuits because of their complexity, the IC greatly simplifies construction by combining the circuits. For those who are perpetual experimenters, the IC's are ideal for they permit complete changing of circuits and are available very cheaply in experimental packages from surplus houses. Design with IC's is fairly simple for only the power supply and the input and output parameters must be considered.

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Circuit Diagrams taken from "RCA linear integrated circuits" c 1967.

References

1. "RCA linear integrated circuits" c 1967, Radio Corp. of America, Harristown, N.J.
2. "Electronic Circuits: Discrete and Integrated" Donald Shilling, Charles Belove c 1968, McGraw-Hill.

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RTTY Tone Generator

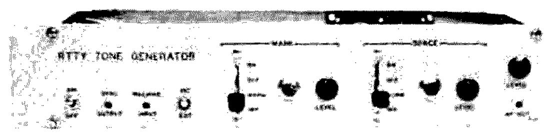
The RTTY Tone Generator is a unique piece of RTTY test equipment. It is capable of simulating a variety of Teletype operating and QRM modes, since it can deliver all possible combinations of the 2125 Hz mark and 2975 Hz space audio tones. When not serving in the test equipment capacity, it functions as a conventional AFSK oscillator.

It may be keyed externally by a contact closure such as from a machine keyboard, or by a 3.5 volt peak-to-peak square wave signal. An internal keying generator provides a zero-bias 22 Hz keying signal. The internal keying signal allows the unit to be used for such things as adjusting TU polar relays and is also a great convenience when chasing signals thru the local system with an oscilloscope.

The unit is designed around transistors and low-cost integrated circuits. It requires 12 vdc (± 10%) at about 450 mA and delivers a maximum audio output in excess of minus 10 dbm into 600 ohms. Front-panel controls adjust the mark/space amplitude ratio and the output level, and select the desired operating mode.

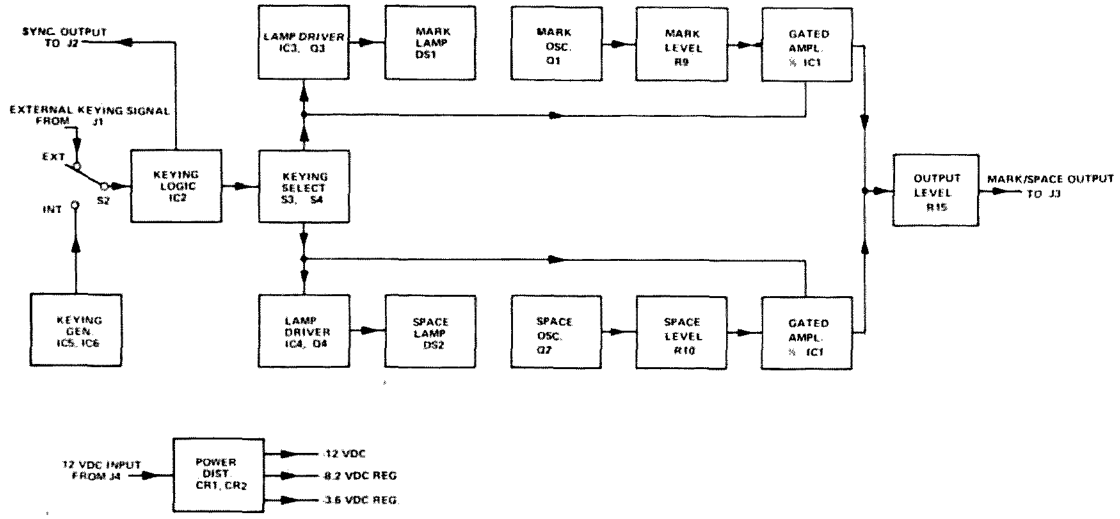
System operation

Fig. 1 is a block diagram of the RTTY Tone Generator. The mark and space oscillator outputs are fed thru separate level controls to independent gated amplifiers. The gated amplifiers stop or amplify their



respective signal inputs depending on the information they receive from the keying logic and keying selector circuits. The audio signals from the two gated amplifiers are combined at the output level adjustment potentiometer. The signal from the potentiometer wiper is connected to the mark/space output jack, J3. The particular combination of the mark and space audio tones present at the output jack depends on the settings of S3 and S4. The following possibilities exist:

a) Mark signal off, space signal off.
b) Mark signal on, space signal on.
c) Mark signal on, space signal off.
d) Mark signal off, space signal on.
e) Mark signal keyed on and off, space signal off.
f) Mark signal keyed on and off, space signal on.
g) Mark signal keyed on and off, space signal on.
h) Mark signal on, space signal keyed on and off.
i) Mark signal keyed on and off, space signal keyed on and off – mark signal present when space signal is absent and vice versa.



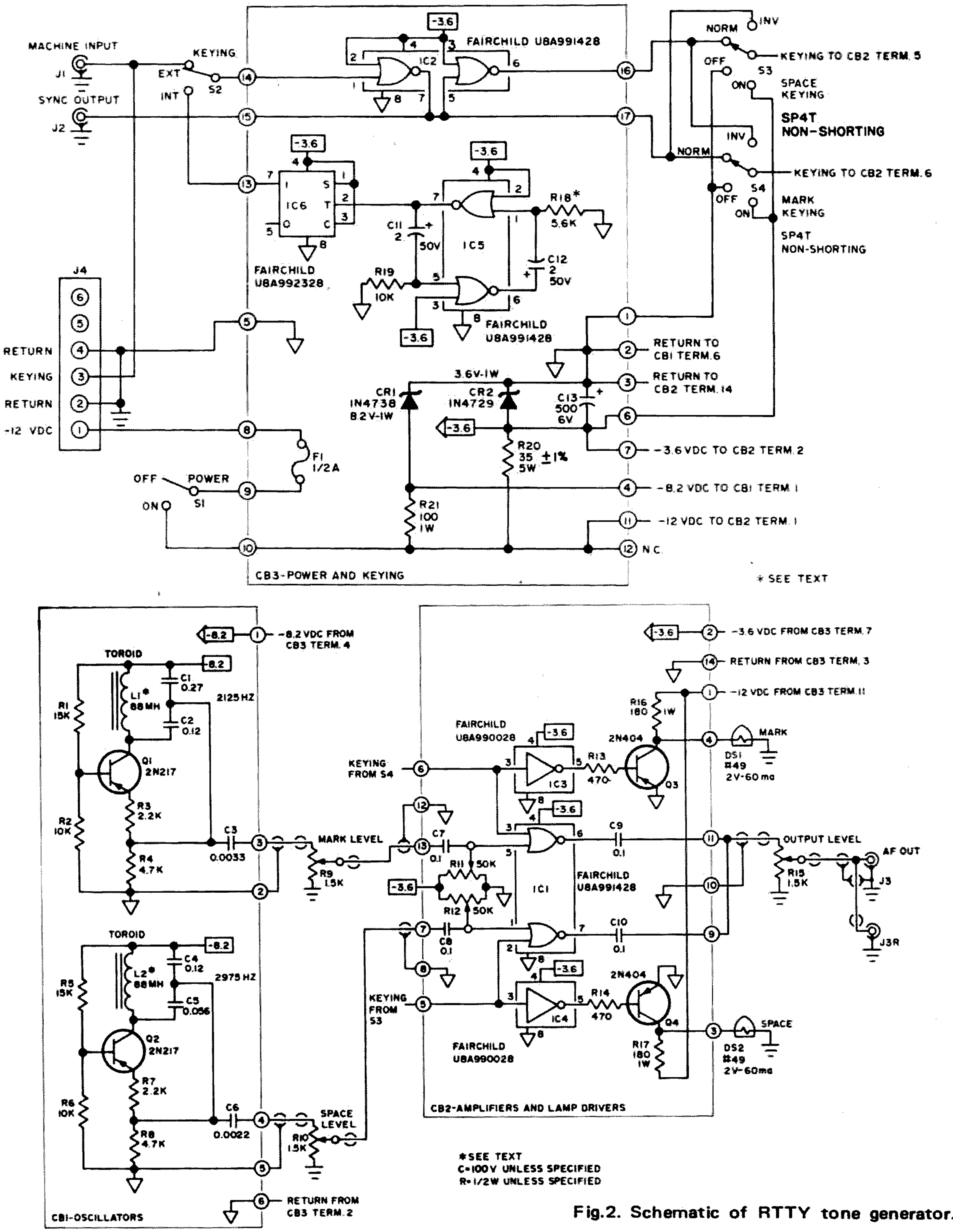
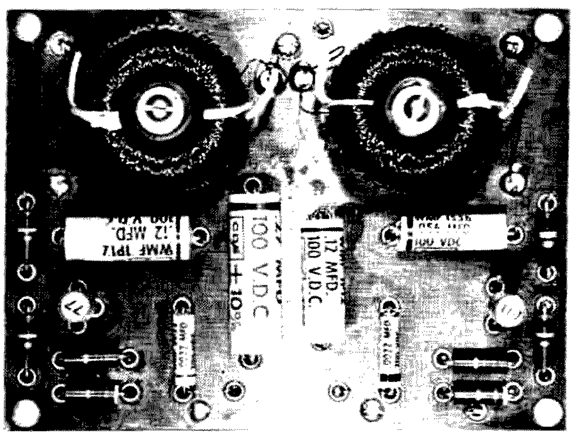


Fig.2. Schematic of RTTY tone generator.

j) Mark signal keyed on and off, space signal keyed on and off – mark and space signal present and absent simultaneously.

The lamps (DS1 and DS2) indicate the state of the two gated amplifiers. They are extinguished when the amplifiers are in the 'stop' mode, and illuminated when the amplifiers are in the 'amplify' mode. The keying selector switch (S2) connects the keying logic input to either the internal keying generator or the external keying input jack. The power distribution circuits provide minus 12 vdc, minus 3.6 vdc regulated, and minus 8.2 vdc regulated to the various circuits.



Oscillator component board. Mark (2125 khz) on left.

Circuit description

The majority of the circuitry is assembled on three 3" x 4" homemade component boards. The mark and space oscillators are contained on one of the boards (CB1), the gated amplifiers and lamp drivers on another (CB2), and the power distribution and keying circuits on the third (CB3). The complete RTTY Tone Generator is shown schematically in **Fig. 2.**

The mark and space oscillators are conventional LC oscillators designed so that their operating frequencies are essentially independent of transistor case temperature. The two inductors (L1 and L2) are the usual 88 mH loading coils. Capacitors C1 thru C6 are mylar dielectric units having a ± 10%

selector switch positions		keying input grounded		keying input open	
mark	space	mark	space	mark	space
on	on	1	1	1	1
on	off	1	0	1	0
on	norm	1	0	1	1
on	inv	1	1	1	0
off	on	0	1	0	1
off	off	0	0	0	0
off	norm	0	0	0	1
off	inv	0	1	0	0
norm	on	1	1	0	1
norm	off	1	0	0	0
norm	norm	1	0	0	1
norm	inv	1	1	0	0
inv	on	0	1	1	1
inv	off	0	0	1	0
inv	norm	0	0	1	1
inv	inv	0	1	1	0

'0' indicates signal absent
'1' indicates signal present

Fig.3. Mark and space outputs as functions of S3 and S4.

capacitance tolerance. Do not use ceramic capacitors in any of the frequency determining networks – ceramics are both temperature and voltage sensitive. Turns are removed from L1 and L2 to adjust the oscillator frequencies to 2125 Hz and 2975 Hz respectively. This will be discussed later in the final adjustments. The capacitor values specified should resonate with any of the available "88 mH" inductors.

The mark and space gated amplifier and lamp driver channels are identical. The mark signal from R9 is fed to one input of a two-input NAND gate. IC1 is a *dual* two-input NAND gate. Potentiometer R11 biases this input (pin 5 of IC1) so that the gate can operate as a linear amplifier. The amplified mark signal appears at pin 6 of the gate as long as pin 3 is at or near minus 3.6 vdc. When pin 3 of the gate is at or near ground, pin 6 of the gate is esentially connected to pin 4 of the gate and the mark signal output at pin 6 disappears. The two-input logic gate thus provides a convenient means for switching (or gating) and amplifying the mark signal. The space channel functions in exactly the same manner, utilizing the two-input gate associated with pins 1, 2, and 7 of IC1.

When terminal 6 of CB2 is at or near ground potential, the mark signal output from IC1 is absent. Pin 3 of IC3 will also be at or near ground potential and the output of IC3 (pin 5) will be at or near minus 3.6 Vdc. This voltage drives Q3 into conduction, extinguishing DS1. The whole procedure is reversed when terminal 6 of CB2 is at or near minus 3.6 Vdc; the mark signal from IC1 may be present (depending on the setting of R9), the output of IC3 will be at or near ground potential, Q3 will not conduct, and DS1 will illuminate. The space lamp driver channel (IC4, Q4, and DS2) functions in exactly the same manner, responding to keying signals at terminal 5 of CB2. IC3 and IC4 are buffer amplifiers. Their sole function is to isolate the lamp driver circuits from the keying signals and assure complete switching of Q3 and Q4.

IC2 conditions the keying signal applied to terminal 14 of CB3. When the keying signal is at or near ground potential, terminal 17 of CB3 is at or near minus 3.6 vdc and terminal 16 is at or near ground potential. Conversely, when the keying input at terminal 14 is at or near minus 3.6 vdc (or open circuited), terminal 17 is at or near ground potential and terminal 16 is at or near minus

3.6 vdc. IC2 is a dual two-input gate operating as two inverters. Only one inverter is required to form the complementary outputs at terminals 16 and 17, but two are used to provide complete standardization of the keying signal.

One of the keying outputs is connected to terminal 15 and brought out to the front panel for use as an oscilloscope synchronizing signal. The keying mode switches (S3 and S4) select either of the two keying outputs, minus 3.6 vdc, or ground, and route the selected levels to the keying inputs of CB2. **Fig. 3** shows the presence or absence of the mark and space outputs with all possible keying/S3 and S4 combinations.

A third dual two-input gate (IC5) is connected as an astable multivibrator that forms the time-base for the internal keying signal. One of the primary requirements of the internal keying signal is that both halves of the cycle be of exactly the same time duration. *If* both sections of the gate were identical, *if* C11 and C12 were identical, *if* R18 and R19 were identical, and *if* the multivibrator were not connected to an external load, its output would be time-symmetrical and therefore suitable as the zero-bias internal keying signal. None of these "if" conditions are readily met in practice. There is, however, a simple solution to the problem, as we shall see.

IC6 is a JK flip-flop. Connected as shown, its output (pin 7 in this case) changes state each time the input (pin 2) switches from 0 *to* minus 3.6 vdc. When the input switches back to 0 *from* minus 3.6 vdc, the flip-flop does *not* change state. Bear in mind that 0 and minus 3.6 vdc are only nominal values and that the flip-flop senses only HI (positive) to LO (less positive) transitions of the input signal. In each complete cycle of the multivibrator output, there is only one HI to LO transition. When the multivibrator output is connected to the flip-flop input, the flip-flop output changes state once for every complete cycle of the multivibrator output. The time duration of each half cycle of the flip-flop output is equal to the time duration of one complete cycle of the multivibrator output. If the flip-flop output is used as the internal keying signal, then the internal keying signal is time-symmetrical regardless of how unsymmetrical the multivibrator output is. This is illustrated graphically in **Fig. 4.** The multivibrator must operate at 44 Hz to provide 22 Hz at the flip-flop output.

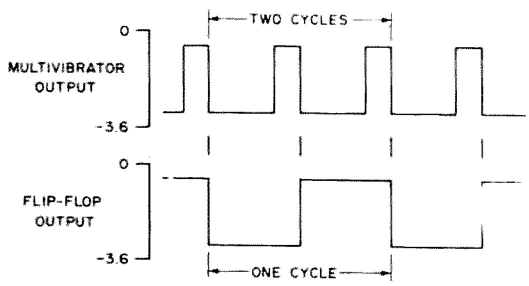
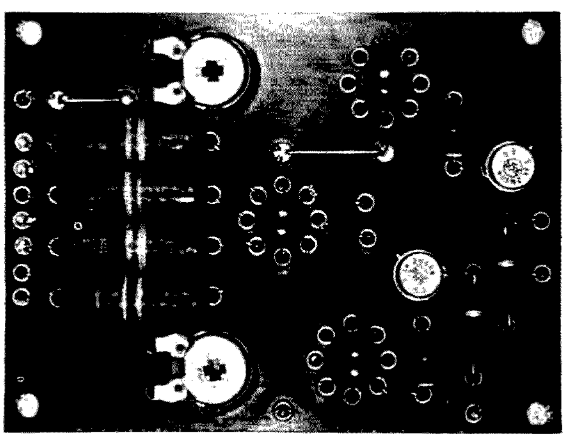


Fig.4. Output of flip-flop.



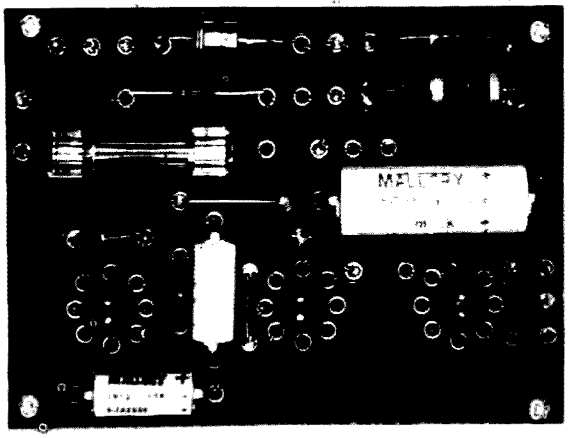
Amplifier and lamp driver component board. The four large capacitors could be replaced with disc ceramics.

The internal 22 Hz zero-bias keying signal from the output of IC6 is connected to switch S2. S2 selects either the internal or external keying signal and applies it to the keying logic input. Referring to **Fig. 3**, the internal keying signal has the same effect as alternately opening and grounding the keying input. When the internal keying signal is at or near zero volts, the "keying input grounded" columns apply. When the internal keying signal is at or near minus 3.6 vdc, the "keying input open" columns apply.

The minus 8.2 vdc and minus 3.6 vdc sources are derived from the 12 vdc ± 10% input by conventional shunt zener diode regulators. Use the resistor and zener diode values and tolerances specified in the parts list.

Integrated circuit data

The integrated circuits I used are manufactured by Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, California 94040, and are available through their distributors. At the time of this writing, the U8A991428 Medium Power Dual Two Input Gate (IC1, IC2, and IC5) costs 80c, the U8A990028 Medium Power Buffer (IC3 and



Power distribution board.

IC4) costs 80c, and the U8A992328 Medium Power JK Flip-Flop (IC6) costs \$1.50. All prices are for quantities of 1 to 99.

These particular IC's are in an epoxy package about the size of a JEDEC TO-5 transistor case. Eight leads spaced on a 0.200" diameter circle protrude from the bottom of the package. There is a flat spot on the outer circumference of the unit – this flat spot is adjacent to pin 8. The remaining pins are numbered *counter-clockwise* looking at the *top* of the package. The ICs are designed for a 3.6 vdc ± 10% supply (pin 8 positive, pin 4 negative). The manufacturer lists their operating temperature range as 15 to 55 degrees C.

Component boards

Each of the three component boards is made from a 3" x 4" x 3/32" piece of micarta or phenolic. Brass eyelets 0.087" O. D. x 1/8" long are used for tie points.

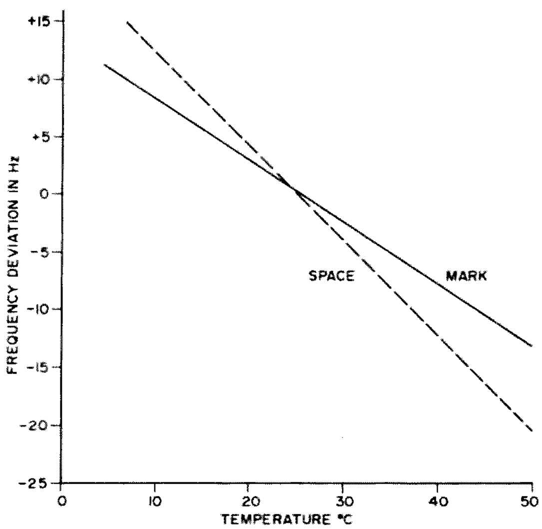


Fig.5. Temperature effects frequency, strangely enough.

The brass eyelets are inserted into all of the No. 43 holes in the component boards from the component side. Make certain the eyelets are pushed all the way into the board, so that the eyelet head is against the surface of the board. Turn the component board over, lay it on a piece of wood and funnel out each of the protruding eyelet 'barrels' with a few gentle taps of a hammer on a 3/8" center punch. I used GC Electronics No. 7251 eyelets and a 3/8" punch identified as 'PROTO 41'.

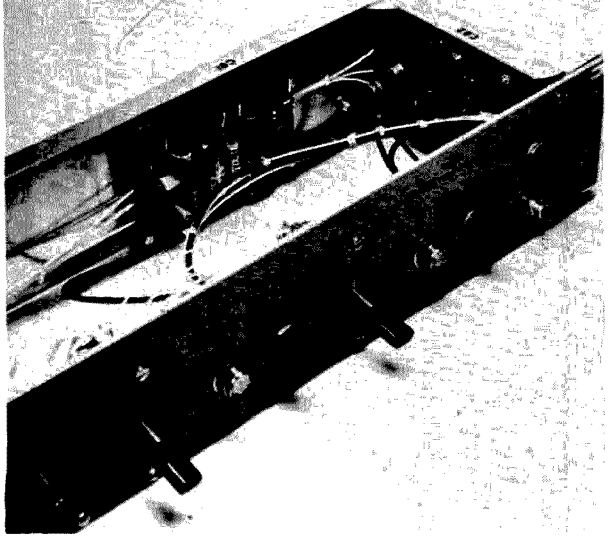
All wiring is done on the back of the component boards in point-to-point fashion with No. 22 AWG tinned bus-bar wire. Insert the wires through the eyelets and bend the ends of each wire over on the component side of the board to hold the wire in place. Clip each wire next to the eyelets on the component side. Insert the components and solder each eyelet from the wiring side. Clipping off the excess component leads completes the component board wiring. The leads of all the semiconductor components should be heat sinked during the soldering operation.

Checkout and Adjustments

After the construction phase is complete, two pairs of electrical adjustments are required to place the unit in service:

a) R11 and R12 must be set so that the gates operate as amplifiers.
b) L1 and L2 must be adjusted (turns removed) to set the exact mark and space operating frequencies.

Connect a 600 ohm (nominal) load and oscilloscope to J3 and set R11 and R12 (on



Component boards 1 and 2 are located as shown. The third board is mounted on the other end of the chassis, opposite CB2.

CB2) to the approximate center of their range. Apply power to the unit and check the minus 3.6 and minus 8.2 voltage levels. Set the mark and space amplitude controls (R9 and R10) to about mid-range and the *af* output level control (R15) fully clockwise.

Place the mark keying selector switch (S4) to "on" and the space keying selector switch (S3) to "off". DS1 should be illuminated and DS2 extinguished. Set the mark amplifier bias by adjusting R11 for maximum amplitude of the mark signal as displayed on the oscilloscope. Maximum amplitude and minimum distortion occur simultaneously.

Place the mark keying selector switch to "off" and the space keying selector switch to "on". DS1 should be extinguished and DS2 illuminated. Adjust R12 for maximum space signal amplitude as observed on the oscilloscope.

Set the internal/external keying switch (S2) to "external". Key the unit at J1 or J4 and check each of the possible keying combinations listed in **Fig. 3**. The responses of DS1 and DS2 should follow the signal output. Place S2 to "internal" and observe that the internal keying signal keys the unit at about a 22 Hz rate. The synch output signal at J2 should be a 22 Hz square wave at this time. This frequency has no particular significance other than being at about the same rate as the keying frequency of a 60 speed machine. If it is too far off, bring it in by changing the value of R18. Bear in mind that each different set of components will have its own frequency vs. R18 characteristics.

Because of the capacitor and inductor tolerances, it is extremely unlikely that the mark and space frequencies will be correct. The frequencies will probably be too low, but can be set to within a few cycles by removing turns from L1 and L2. Go easy here – it's a lot easier to keep on removing turns than it is to start adding them back. The frequencies may either be compared with an accurate audio (or AFSK) oscillator or measured with a frequency counter. The mark signal should be at 2125 Hz and the space signal at 2975 Hz. Soldering iron heat conducted to C1, C2, C4, or C5 will affect the oscillator frequencies. Frequency measurements should be made only after the capacitor temperatures have stabilized.

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General Purpose Good-Bad Transistor Checker

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A good-bad test on a transistor can be devised on the basis of simple checks which can reveal the existance of a short or open condition between elements.

AM ohm meter reads resistance of a substance by applying a small voltage across the material. If the resistance is slow, the applied voltage can force a relatively high amount of current through the unit. The meter indicates the amount of current on the scale which is calibrated in ohms.

The instrument will bias the transistor in both directions. If forward bias occurs, large current flows indicating the resistance is low. Reverse bias will indicate at least a ratio of 20 to 1, if the transistor is normal. If a transistor does not respond as described, it may be considered defective. However, weak units, or those with leakage between elements, might respond satisfactorily. This test is basic and only intended to indicate whether the transistor is completely inoperative. Better quality checks are possible with a number of commercial testers on the market.

Make sure all checks with the tester described are made with the ohmmeter set to the highest resistance range which gives a convenient reading. Certain types of transistors that are not classed as general purpose may be damaged by the voltage from the ohmmeter.

The purpose of the tester described in this article is to simplify as well as speed the test in a comfortable and stable position. Whether the transistor is PNP or NPN, simply plug in the unit, connect the ohmmeter to the banana jacks input, set the meter to the highest range that will give the convenient reading, set sw2 to the test position (position 1) to - zero the meter. Then make transistor checks for E-B in No-2 position, E-C in 3 position, B-C 4 position and No. 5 for diodes, with the diode in the diode jack, of course.

In the diode position, it is also possible to check condensers for open-short. If it is desired to check components in circuit and if conditions warrant it (one end of component disconnected), simply run a pair of test leads with alligator clips at the diode jacks, leave switch 2 in diode. position and use reversing switch 1 to test forward and reverse currents.

Or if desirable, the No. 6 position can be used to run a pair of test leads directly, or perhaps another set of jacks to hook up the test leads.

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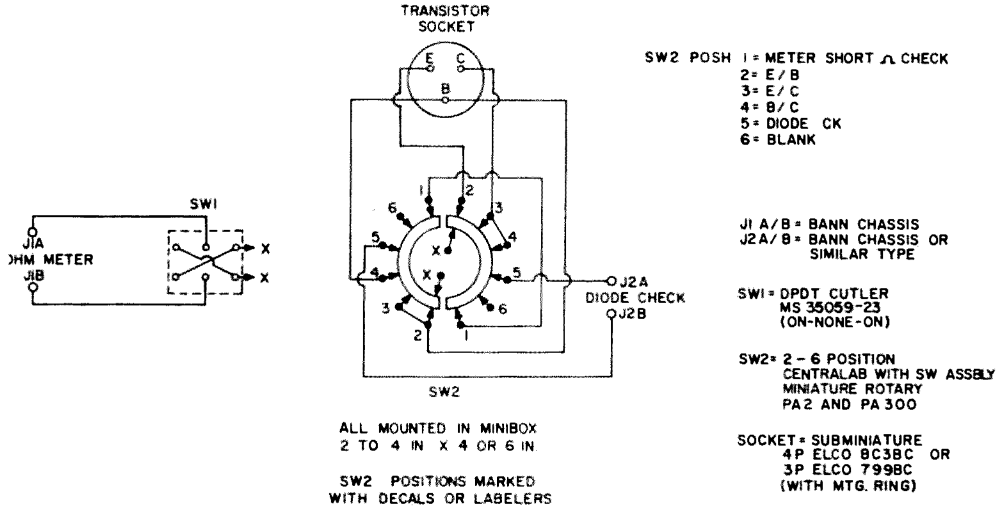

Fig. 1. Schematic diagram of the general purpose, Mark 1 transistor checker.

A Compact Two-Meter Transmitter

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Why must home-brew 2 meter gear always look like a breadboard project? Is it really necessary to rearrange your entire station and break out a vtvm and vswr bridge in order to get it on the air? The answer, of course, is that VHF gear can often be built just as compact and with all the control circuits of HF rigs – without the final serving double duty as a multiplier.

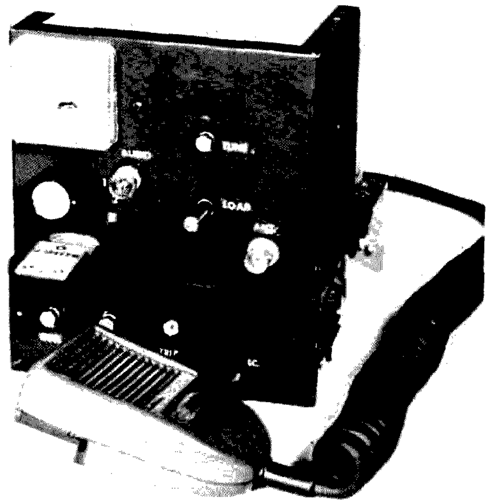
You may make a few isolated QSO's with your nano-watt, super flea powered special, but don't try to sign into a net with it – not even a local net like our MARS club here in Northwest Florida. You'll end up answering the roll, then sitting back and reading the mail until sign-off time. This doesn't mean you have to melt down all the TV antennas in your neighborhood. It does mean you need a respectable 7 to 10 watts with good modulation, and a way to check both without someone warning you that you're splattering all over the band.

Having gone this far, why build it on an open chassis? Why not a small, compact, attractive transmitter with a front panel, push-to-talk control circuits and selectable metering which may be tuned and loaded without once having to tip it up on end to get a vtvm probe on that doubler grid?

This small (5" x 6" x6") rig was built mostly out of junk-box parts and has received excellent reports on the air. It has a measured output of 7 watts with about 85% modulation, and most important of all, has caused my TVI complaints to drop to zero. In net operation, it has about the same power level as most of the small commercial models, enabling you to sign in without apologizing. It may be tuned and loaded from the front panel and put on the air after a few minutes' warm-up.

Circuit Description

The transmitter is self-contained, except for power supply. A small illuminated type



W4UOY has made a neat package.

"S" meter monitors doubler grid, P. A. grid and relative power. The push-to-talk relay applies voltage to the oscillator plate, multiplier plates and P. A. screen. It also removes ground from the first audio amplifier in the receive mode. A front panel slide switch removes P. A. screen voltage during preliminary tune-up to prevent damage to the 2E26.

The oscillator is a conventional Colpitts which may be either excited with an 8 mhz crystal or driven with an external VFO. The oscillator plate is tuned to 24 mhz and contains a fixed 10 pf capacitor to prevent peaking on the wrong harmonic.

The first half of a 12AV7 triples to 72 mhz and also contains fixed capacitance to keep it in the proper harmonic range. If the coil data supplied is followed closely, the tuning will be straight-forward and all of the tuned circuits will only peak on the proper harmonic. The second half of the 12AV7 doubles to 144 mhz and drives the 2E26.

When properly neutralized, the 2E26 offers a low impedance load to the 12AV7.

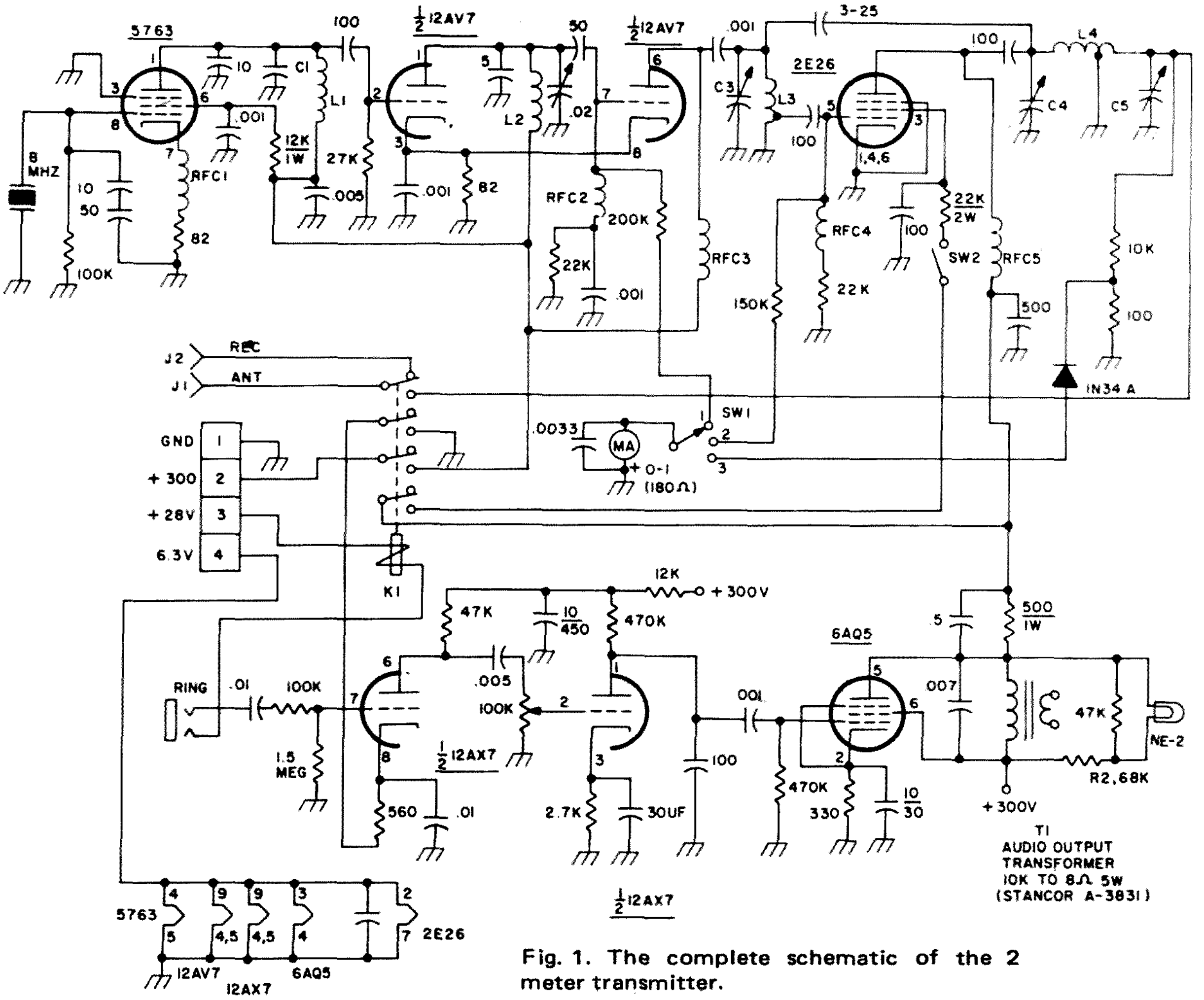


Fig. 1. The complete schematic of the 2 meter transmitter.

The driving voltage is tapped down on the driver tank coil to provide a proper match. It was found, experimentally, that a point ¾ turn from the ground end of L3 provided the proper amount of drive.

The audio section uses a 12A X 7A and offers a good match to most of the hand-held crystal or ceramic microphones. I used choke modulation because I later plan to build a small companion receiver. By using an audio output transformer for the modulation choke, the audio section of the transmitter will also serve as the audio amplifier and output section of the receiver. For the present, the 8 ohm winding of the transformer is left open. At 85% modulation the voltage drop across R1 just exceeds the firing point of an NE-2, so the bulb was panel mounted for a visual check of modulation. During operation the microphone gain is advanced until the NE-2 just flickers on voice peaks for a safe modulation level.

Construction

The main chassis is a 6" x 5" x 2" U shaped piece of aluminum. The front panel is the cover from a 5" x 4" Mini-box cut to shape. A 3" x 4" aluminum shield is mounted between the 12AV7 and the 2E26. The top, back and sides were covered with perforated cane-metal aluminum (not shown).

Under the chassis, the three coils are mounted at right angles to each other and the three tuning capacitors are mounted in line across the front edge. The microphone jack, microphone gain pot, and power plug are mounted on the rear. The receiver antenna connection is also rear mounted. The push-to-talk relay was scrounged from an old surplus computer chassis, along with the small 24 volt transformer to power it. Any 4-pole double-throw relay would have served just as well and could be powered from a divider across B+. (This, however, would result in B+ appearing on the microphone switch when the transmitter is unkeyed.) A rigidly mounted, preferably silver-plated coil should be used for the output tank coil – the other coils were wound from No. 16 AWG nyclad copper wire.

Top view of the 2 meter transmitter.

Tune-up and operation

After the wiring has been completed and checked, plug in only the 2E26 and apply power. The first step will be to neutralize the 2E26. With the meter switch in position 2 (P. A. grid), set the doubler tuning capacitor (c3) to about half range. Turn the P. A. screen switch on. With the microphone in one hand and the other hand on the P. A. tuning capacitor, key the microphone and quickly rotate the P. A. plate tuning capacitor through its entire tuning range. Do not keep the mike keyed for longer than 2 or 3 seconds or the 2E26 may be damaged. If there is a flicker of grid current while swinging the capacitor (it is almost certain there will be on the first try), change the setting of the neutralizing capacitor slightly and try again. When properly neutralized, the 2E26 will show no grid current at any setting of C3 or C4.

After the 2E26 has been neutralized, remove power, turn the P. A. screen switch off and plug in the other tubes. With the meter switch in position 1 (doubler grid) peak C1 and C2. The meter in this position has a full scale deflection of approximately 200 volts, so you should get at least half scale deflection. C1 and C2 should also be peaked as quickly as possible, since both halves of the 12AV7 depend largely on grid leak bias for protection. Both plates will show color rapidly with the transmitter keyed and the two capacitors not peaked.

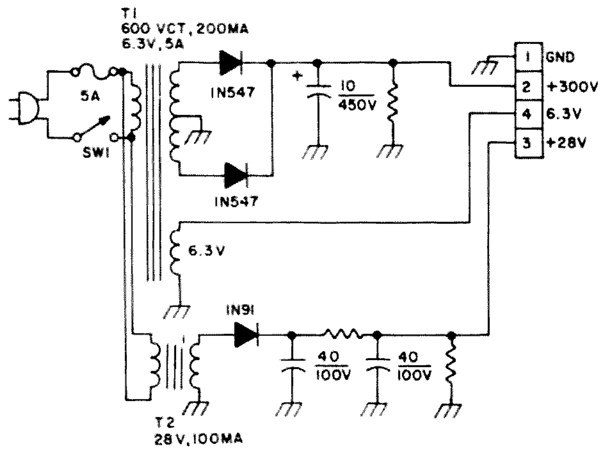
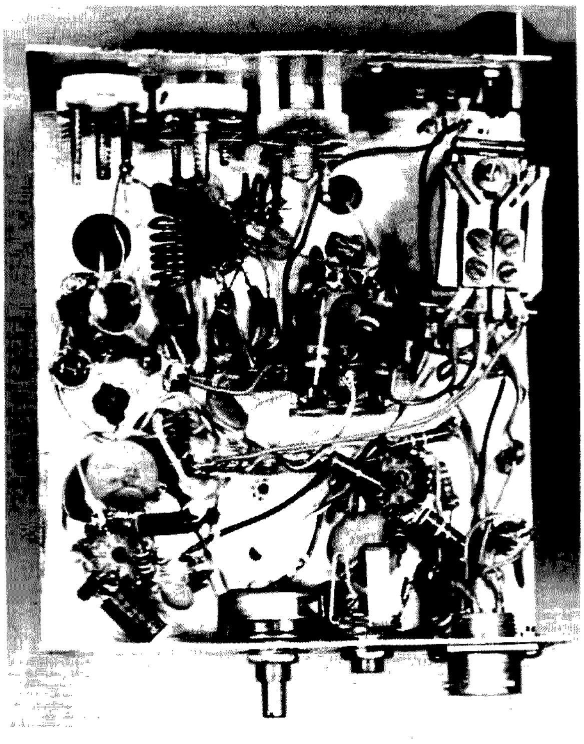


Fig. 2. Power supply diagram.

Next, place the meter switch in position 2 and peak C3. (After the set is loaded you will have to come back and re-peak C3 to a slightly lower capacity setting.) After the P. A. grid has been peaked, turn the P. A. screen switch on and put the meter switch in position 3 (relative power). Connect a G. E. No. 46 (blue bead) light bulb to the antenna jack for a dummy load, key the mike and peak C4 and C5. As you peak C5 the light bulb should glow with a brilliant white light. Turn the meter switch back to position 2 and re-peak C3. The rf section is now tuned and loaded.

While talking in normal tones into the microphone, advance the microphone gain control until the audio light on the front



Bottom view.

panel just flickers on voice peaks. The dummy bulb should show an appreciable increase in brilliance when you talk into the microphone. To load into an antenna, simply peak C4 and C5 with the meter switch in position 3.

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Parts data

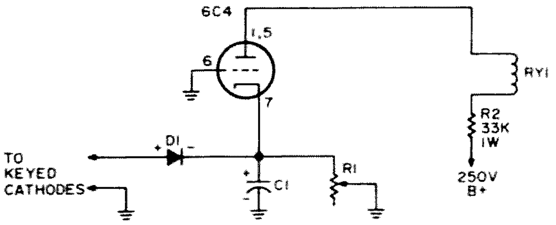
Rfcl – 1 mH
Rfc2 – Ohmite 2-50.
Rfc3 – Ohmite 2-144.
Rfc4 – Ohmite 2-144.
Rfc5 – 22 turns No. 24 CW on ¼" d.
LI – 11½ turns No. 16, ½" d. (B&W)
L2 – 5 turns No. 16, ½" d. 7/8" long.
L3 – 3 turns No. 16, ½" d. ½" l. tapped ¾" from ground end.
L4 – 4 turns No. 16, tapped 1 turn from ant. end.
CI – APC50 with all but 8 plates removed.
C3,4 – APC25 with all but 4 plates removed.
C5 – APC50.

A Simple CW VOX for Cathode Keyed Transmitters

After sending in my application for Navy MARS, I was left with a juicy problem. Since I didn't have any SSB gear, I was stuck on CW. That meant I had to modify a little CW rig for full break-in traffic handling.

After trying everything in the book, along with some things which aren't in the book, I came up with the following circuit.

This little job can transfer your antenna either at fast keying speeds for traffic handling, or you can set the delay for those long rag-chews with the Novice down the block. D1 isolates the VOX from the transmitter keying circuit. R1 determines delay time.



There is a setting of R1 which keeps the relay closed. If you don't like to fool with critical settings of R1, add a resistor to ground.

Because of differences in key voltage and relay characteristics, you may have to change the value of CI to get the delay which suits you best. And, you won't even have to send BK. . .That first dot is always on time!

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Measuring f_t of Surplus Transistors

The usual procedure for determining the *rf* capabilities of unmarked transistors involves plugging the units into a standard oscillator circuit and then playing with circuit values until oscillations start or the experimenter's patience gives out. Fortunately, there are simpler and more accurate methods of judging a transistor's capabilities. This article will be concerned with the measurement of a transistor's current gain – bandwidth product, usually referred to as its ft. This is the frequency at which the common emitter current gain has decreased to a value of unity. This is also one of the most useful parameters to know since a transistor can be operated as an amplifier or oscillator up to and even beyond its ft. A simple and practical test circuit will be presented and the theory behind its operation will be discussed.

The most common method of determining the ft involves measuring the high frequency current gain, hfe, at a point which lies above the beta cut off frequency, fB. Beta, or B, usually refers to the low frequency current gain. A simple graph will help illustrate the meanings of the above parameters. Fig. 1 shows what the plot of a uhf transistor's current gain versus frequency might look like. The definition of fB is the frequency at which the common emitter current gain is down 3 db from its low frequency value (see point A). In this example it equals 10 mhz. At twice fB and higher, the current gain falls off at a rate of 6 db per octave or 20 db per decade of frequency. Finally, at a frequency ft, the current gain has reached a value of unity or 0 db (see point C). In this example ft equals 1000 mhz. This -6 db per octave slope has the property that the product of the current gain and the frequency at any point on the slope equals ft. For instance, at a frequency of 100 mhz, hfe equals 10 and the product of the two equals 1000 mhz (see point B). This is the measurement we shall have to perform on our unmarked transistor to get a firm idea of its high frequency potentials.

Before proceeding into a description of the test circuit, we must define hfe: it is the small signal (linear) current transfer ratio from base to collecter with the collecter and emitter short-circuited and the base open-circuited (for ac current only). This condition can be represented by the circuit shown in **Fig.** 2 where biasing circuitry is omitted. The output current is measured by the ammeter Ic, which also presents a short circuit load to the collecter. The open circuit at the base can be represented by a current source Is at a frequency fs, which, theoretically, has infinite output impedance. The

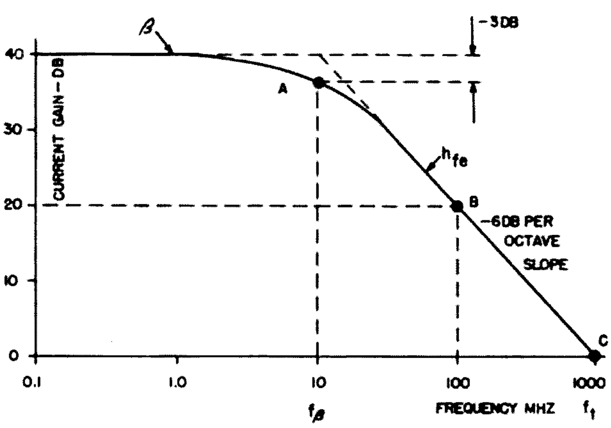

Fig. 1. Typical plot of transistor current gain versus frequency.

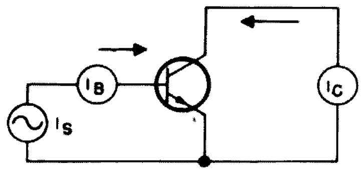

Fig. 2. Idealized test circuit for measuring hfe of a common emitter stage.

base current is monitored by another ammeter labeled Ib. Since the emitter is already at ground potential the circuit satisfies all the requirements imposed on the measurement. It is not, however, very practical since it requires milli- and microammeters capable of measuring currents at a few tens of megahertz.

A practical approximation to the above is the circuit shown in Fig. 3. I have designed this particular circuit to sort my personal stock of unmarked goodies into useful regions of frequency. The 10k resistor in the base acts as part of the bias network and also transforms the input voltage vi into a current to drive the base of the transistor-undertest. This resistor makes a fairly decent current source if the transistor input resistance is under 1k ohm. This is a reasonable condition at the dc emitter current level and the frequencies of interest here. The 51 ohm resistor provides a termination for the signal generator used as a source. In the collecter circuit the 68 microhenry choke acts to pass dc current and block ac current. The ac collecter current is almost completely absorbed by the 51 ohm resistor used to approximate the short circuit load. The load resistor converts this output current into a small voltage which can be measured with an *rf* millivoltmeter.

Thus the measurement boils down to measuring vo and vi and then plugging the values into the following equation:

$$\text{equation: hfe} = 200 \times \frac{v_o}{v_i}$$

The factor 200 represents the conversion factor between the voltage gain and the current gain of the circuit. This constant is equal to Rs/RL and was made to be convenient while satisfying the other requirements. ft is found by multiplying hfe times the frequency of measurement. It can be seen that the voltage gain will be much less than one hence the need for a millivoltmeter.

There are a few precautions which must be observed in order to use the circuit successfully. The input voltage should be adjusted such that the output is in the range of 10 to 50 millivolts rms, preferably closer to 10 millivolts. This will insure that the transistor is operating under small signal, or linear, conditions. The frequencies used should be limited to the range of about 5 to 30 mhz. The hfe should be measured at a couple of frequencies and the results examined to insure that the final measurement is being performed on the −6 db per octave slope. The voltmeter ground clip should be attached close to the point of measurement. The supply voltage should be positive for npn and negative for pnp transistors. Either silicon or germanium types can be tested in the circuit.

With a 12-volt supply the collecter current will be about 4.5 ma and the collecter to emitter voltage will be about 9 volts. The collector current can be changed at will by decreasing the value of the 680 ohm emitter resistor for a larger current and increasing it for a smaller current. You may want to characterize a transistor at a number of emitter currents since this has a direct effect on the ft. Starting at low currents, ft increases with increasing emitter current. A region will be reached (usually a fairly high current) where the ft will begin to decrease. The operating point in this circuit was chosen such that it will fill most requirements.

The circuit layout should be as tight as possible. Special care should be taken to keep the leads in the bypass and coupling capacitors as close to zero length as possible. A transistor socket should be used for convenience in testing large numbers of transistors. A copper clad board would be ideal as the bypass caps can be soldered directly to the ground plane. Standoff ter-

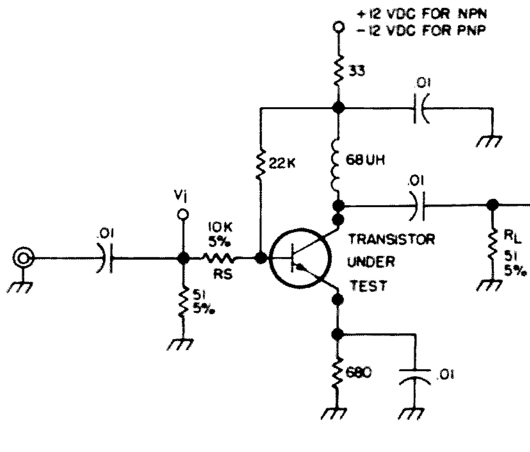

Fig. 3. A practical test circuit for measuring hfe.

minals can be used at the measurement points for easy access with the voltmeter.

Most experimenters own or have access to signal generators for use as a source of *rf.* An *rf* millivoltmeter can be scrounged somewhere with enough searching, or a simple one can be built if you can find a signal generator with an accurate attenuator to calibrate it with. My own voltmeter is homebrew using a couple of crystal diodes and a dc amplifier using FETs and transistors. Lowest range is 10 millivolts full scale. I find an instrument of this sort indispensable when working with solid state *rf* circuits.

No article about test equipment or set-ups is complete without some comments on accuracy of measurements. Some tests were conducted with transistors having known ft's. The results indicate that the readings will be about 5 to 25 percent low. This error can be attributed to the imperfect current source and short circuit load used. To make the readings more accurate would require either more sensitive meters or a more complex circuit requiring adjustments for each measurement. This set-up fills the bill for making quick tests on a bunch of bargain basement transistors. For instance, one of the IBM boards in my junk box yielded a dozen germanium transistors with ft's in the range of 300 to 400 mhz. In my opinion this piece of information was well worth the time it took to build this test circuit.

. . . WA1FRJ

Jim Ashe, W1EZT

Skylines for 160, Made Simpler

About a year ago the value of 160 meters as a ham band was much less than now. The regulations were too confining. New regulations, although complex, offer much more opportunity for local ragchewing, and some adventurous amateurs may be working transoceanic DX even as you sit reading this.

Your on-the-air competition on 160 will be far less than on 80, the propagation much steadier than on 20. Effective ranges are typically several tens or a few hundreds of miles. And at 160's low frequencies you can get by with inexpensive surplus transistors to try out those transmitter ideas. 160 is worth some of your time and money now.

There's a bit of history on 160, too. It is on the dividing line between two very different kinds of radio. Now it's at the bottom of the amateur spectrum, but there is a time in some men's memories when it was at the top. Communications engineers once believed you used long waves for long range communications, since nobody understood how short waves could get over the horizon.

The general thinking then was that the high frequencies had a low practical utility, and the amateurs wound up with a huge chunk of radio spectrum nobody else wanted. Many interesting records date from that time for the hams soon discovered the real potentialities of short-wave propagation.

Now we understand the differences between ground-wave and sky-wave propagation. We know why the ionosphere is responsible for sky-wave propagation, since its effects cannot be ignored by anybody and are very important for the DX that interests many amateurs. And we have a band where the special advantages of ground-wave propagation can be applied and enjoyed.

Ground-wave is made to order for local rag-chewing. Saving the higher-frequency bands for DX, we can easily build simple antennas optimized for 160 meter vertically polarized radiation. In a way this is making a virtue of necessity, but we can come back to that point later. First we should discuss the FCC's complex frequency and power assignments, and review some facts about 160 meter propagation.

Eight Pieces of Pie

When you tune your receiver across 1.8 to 2.0 MHz you will hear a variety of sharp regular beats, quite evidently for some purpose other than communication. These sounds first appeared on 160 during WW2, when a tremendous need was developing for some fast, reliable, and accurate method of navigation. Ship and airplane navigators observe the beats in pairs on an oscilloscope-like indicator. Then, using the resulting time measurements and special navigation tables, they quickly locate their vessels with an accuracy of a thousand feet or so. This service was very useful during the war, and has had a great commercial value since.

The system is called "loran," coined from "long-range navigation." Various engineering necessities plonked this service into the amateur 160 meter band, where it has stayed to the annoyance of many hams. With the loran usage receiving first priority and the hams reduced to low powers in the face of kilowatt pulse interference, 160 meters has become a less-than-popular band for amateur communications.

But navigation technology has been developing, and with the advent of new navigational space satellites, UHF beacon systems, inertial navigation, and computerization (which saves time and improves accuracy) the loran services have lost importance over the past ten or twenty years. Recently the FCC has raised and reallocated its 160 meter power limits. This easing together with the development of amateur technology has made the band interesting again.

Yet the 160 meter band is still a shared service, and the FCC has written a remark-

ably complex set of rules for the amateurs. The new regulations appear to occupy more space and text than all the other regulations for all the other amateur bands. If you intend to operate legally you have to 1) determine in which of 26 American or several zones you will operate; 2) discover which of the eight 25 kHz frequency segments are available to you in those zones; 3) make a list of the daytime power limits applicable, and 4) add a list of the much lower night-time power limits. Finally, look out for rules changes. Considering the complexity of the allocations, changes seem quite likely.

At this writing, the regulations break the continental U.S. into 26 areas. All dividing lines are among state lines. Some areas, such as California, Texas, or Florida, consist of only one state. And at the opposite extreme, the Northeast U.S. includes the entire W1 and W2 zones as a single allocation area. Fig. 1 is a representative table of the allocations for New York State and some adjacent areas.

NEW YORK STATE

Segment	Day/Night Power
1800-1825 kHz	500/100 W.
1825-1850 kHz	100/25 W.
1850-1875 kHz	0
1875-1900 kHz	0
1900-1925 kHz	0
1925-1950 kHz	0
1950-1975 kHz	0
1975-2000 kHz	0

Fig. 1. Sample allocations for one state. Which limit applies at 1825 kHz?

In each of the allocation areas the 160 meter band is broken into eight 25 kHz segments with typically different power limitations for each segment. There is no clear pattern, except that the highest power limits *tend* to appear at the edges of the band, and there are very many parts of the U.S. in which the central two to four 25 kHz portions cannot be used at all.

The present power limits range from zero at any time right up to 1000 watts, with 200 and 500 watt limits being quite common. Power is measured in the standard manner. The power limits are reduced by a factor that is typically 4 and occasionally five when the sun goes down, and there are no night-time limits anywhere over 200 watts. This complicated power limit system is going to lead to considerable band-edge or cross-segment operation, and more than any other band 160 will be an easy one to earn a pink ticket for incorrect operation.

Fortunately all of the segment borders are at multiples of 25 kHz, so that you can use a frequency standard consisting of a 100 kHz oscillator followed by a pair of binaries to provide good 25 kHz markers. Since the recent incentive licensing regulations changes for the higher bands also place band segment borders on 25 kHz multiples, appropriate frequency standards are appearing on the market and should also be available as construction articles. Alternatively (since the segments are quite narrow) crystal controlled operation deserves consideration.

160 Meter Propagation

If you know something about radio wave propagation on the higher bands you will not need any new concepts for 160. The principles are about the same as on 80 or 40 but the emphasis has gone from sky waves to ground waves. When operating on 160 meters, especially at night, the skip distance is about zero so that sky and ground waves compete at all distances. 160 can offer severe fading problems.

This fading is minimized by antennas that minimize upward radiation. A 5/8 wave vertical would be a pretty good radiator for 160, and a set of three cophased half-waves stacked vertically would be even better. But all that is out of the question for any builder who is not financed by the Government or a large industry. Work out the dimensions and you'll see why. If you're typically limited in money and resources you must get by with some pieces of wire attached to available structures and trees. Or maybe you can do something with a few lengths of TV tower.

Ground-wave propagation is the apparent passage of the radiated *rf* along the ground. See Fig. 2. The wave fronts are the usual one-wavelength apart, and extend far up into the sky. They tilt forward because ground resistance is dissipating part of the wave energy. The tilt is an indication of the rate at which the wave is passing into the ground (where it is permanently lost) and depends

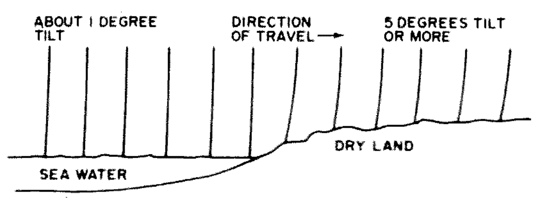

Fig. 2. Since the wave front proceeds at right angles to its surface, the tilt is an indication of the rate at which it is running into the ground. This tilt is applied by the Beverage antenna.

upon the electrical conductivity of the ground. The greatest tilt is seen over the poorest surface, which gives you the least range.

On 160 you can fairly well expect to get out to one hundred miles by ground wave, and you may do very much better than that. It depends upon the quality of the earth in your region, and upon how much competition your signal gets from electrical interference and Loran signals at the point of reception. The Loran signals can be filtered or clipped, and so electrical noise is probably the controlling factor. The situation may be

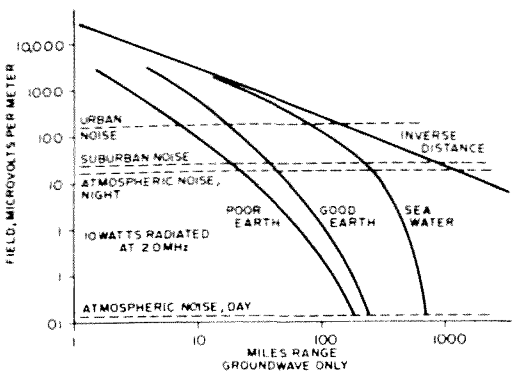

Fig. 3. Local noise, rather than receiver sensitivity, will often limit your effective range. You will not need high powers for reliable contacts if you are in a quiet area.

surprisingly good at your site, or worse than you believe. This will have to be learned by test, but you can get some ideas from **Fig. 3.**

This chart refers to ground-wave signal strength only. We could draw a few tentative conclusions about the fading zone from this, if we knew the radiation pattern of your antenna, but that is not the purpose. Here we are seeing what 10 watts radiated power is likely to achieve against some typical noise competition. Since you will typically be radiating considerably more power than 10 watts these are probably minimum results. To adjust this chart to higher powers, correct the field strength by the square root of the change. That is, if you were radiating 1000 watts, the received signal at any given distance would be greater by a factor of ten.

Unless you are interested in 160 meter DX you will find sky-wave propagation appears largely as a source of trouble. It is not true that if a receiving antenna picks up the same transmitted signal from two directions the receiver gets twice the input signal. The receiver may not get any signal at all, if the two incoming signals are of equal amplitude but opposite phase. In that case they cancel. When incoming signals are in the general

range of two or three to one in power level you have a possible signal-cancellation situation, and if one of the signals is reflected from a moving object or surface you can expect some fading. This is the effect sometimes seen on TV sets as aircraft fly across your area.

Replacing the aircraft by the ionosphere we find that under some conditions the sky wave may return to earth at a region not very different from the transmitter, and compete with the ground wave. See Fig. 4. This effect is more noticeable on 160 than on any other ham band, more likely at night than in the daytime. We cannot revise the ionosphere to remove the fading, but we do try to design our antennas for minimum upward radiation.

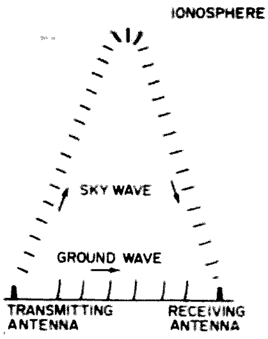

Fig. 4. If the sky and ground waves arrive at an antenna with roughly equal amplitude, a bad fading situation is likely. Good antenna design minimizes sky wave radiation.

160 Meter Antenna Principles

If you are accustomed to antenna work at 20 or even 80 meters your first thoughts about 160 meter antennas may bring a bit of a shock. The 5/8 wave vertical mentioned earlier would be 330 feet high, and the three cophased half-waves would get you up to 780 feet of tower. A mere quarter-wave vertical would be over 100 feet high! Looks like a job for a junior financier to purchase an adequate supply of building materials and

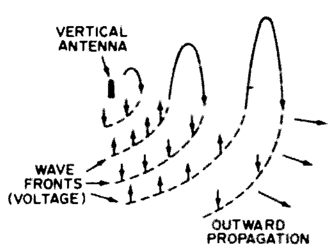

Fig. 5. Here is a partial image of the ground waves radiating outward from a vertical antenna. If the antenna were tilted its radiation pattern would include horizontally polarized components, resulting in an apparent loss of signal strength.

a senior engineer to get them all in place without upsetting the neighbors. Fortunately, we can assemble good 160 meter antennas without forming contracting and legal partnerships. But we must understand two key ideas.

First, as emphasized in the section on propagation, we are concerned with which way the radiation goes, and with its polarization. It turns out these requirements do not conflict, since the vertical polarization we need is most effectively generated by the vertical antenna we can probably build. See Fig. 5. This same antenna ideally has zero vertical radiation and if we can only make it tall enough it radiates most effectively toward the horizon. Probably we cannot make it tall enough, but we'll just have to live with that. To see the effects of various antenna heights look at Fig. 6.

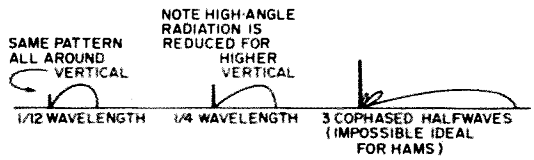

Fig. 6. Increasing the height of the vertical portion of your antenna reduces high-angle radiation *and* increases low-angle radiation.

The second key idea, but not second in importance, concerns matching power into the antenna. Hams use quarter-wave and half-wave dipole elements at the higher frequencies because these electrically special lengths guarantee convenient properties, as illustrated in Fig. 7. But it is not true such electrically sizable structures are good radiators *because* they are easy to feed!

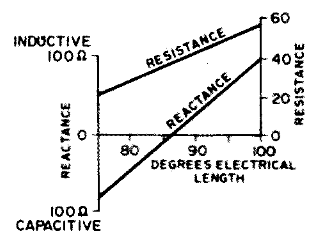

Fig. 7. Here is a quarter-wave vertical working against ground. Its electrical appearance depends upon its electrical length (or upon frequency if the length is held fixed).

A close examination of the VLF engineering literature reveals the pair we think are Siamese twins merely occupy the same cradle. If we apply a bit of intelligence we can separate them completely without disturbing Mother Nature at all. We can make electrically small structures that radiate *rf* power very effectively, if we can solve the feeding

problem, and we will have excellent receiving antennas too.

Now we are concerned with the popular VLF problem of feeding electrically small structures. In good engineering style perhaps we decide to start out with an equivalent circuit. Can we draw an equivalent circuit of our antenna even before we have built it? Yes, because the variety of antennas we are likely to construct for 160 meters is not very great, and if we choose the correct equivalent circuit it will work for any antenna anyway. An appropriate circuit appears in Fig. 8, which shows an inductance, a capacitance, and two resistances in series. This equivalent circuit relates to our real antenna very simply.

The equivalent circuit shows a complete loop from the coax cable center terminal around to the cable's outer conductor. This is perfectly legitimate, even though we cannot see a wire connection between these terminals in many antennas. The connection is there, completed by the *rf* power that flows in the space surrounding the antenna. Maxwell used the term "displacement current." This current, a voltage, and a magnetic field may be observed in the space between capacitor plates as well as in the space around antennas. If you can accept the completeness of an ac current loop through a capacitor, you can apply the same reasoning to a real antenna in space.

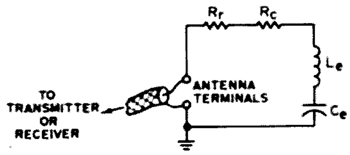

Fig. 8. An equivalent circuit that will express the characteristics of the antenna of Fig. 7, or of any other antenna, at or near a given frequency.

Next, we are concerned with the lumped capacitance, C_e, and the lumped inductance, L_e. This is an approximation of the antenna's real capacitance and inductance, which are distributed along many feet or tens of feet of physical antenna. The approximation works if we suppose we are discussing the antenna at a particular frequency or in a narrow band of frequencies. For instance, if we are thinking about a half-wave dipole fed by twinlead and operating at its resonant frequency, we ignore the capacitive and inductive reactances because at resonance they are equal and opposite in value. On 160 meters we are usually concerned about these reactances since the antenna is probably opera-

ting below its natural resonant frequency.

R_c is merely the effective resistance of all the conductors making up the antenna. That includes the very important ground resistance. If we want to achieve the best possible antenna efficiency R_c gets close attention because it sees the same feed current the real radiating part of the antenna sees, but it dissipates that power as heat rather than as *rf* field. R_c will be larger than the dc resistance of our antenna assembly because of skin effect, which confines *rf* current to the surface of the conductor.

This clues us in to a key point. Mere good ground practice is not the best we can do. We want to put up an antenna with the maximum possible amount of current-carrying surface, and that surface should be clean and shiny. We will have to protect it from our polluted and corrosive rainfall with insulation or good paint so that R_c is not gradually increased to some high value.

Finally, and here is the hero of our story, there is R_r. This is the purpose of our antenna, with L_e, C_e, and R_c appearing as unavoidable camp followers. R_r is not a loss resistance, it is the resistance that accounts for the actual radiation of useful *rf* into space. Since this energy seems to be lost from the system the transmitter and the antenna circuit see it as a resistance which dissipates watts as I^2R_r. This is the same familiar rule by which we estimate the watts dissipated by a resistor, and I is simply the current, which you can measure with an *rf* ammeter, fed into the antenna.

Now we can apply these ideas to a particular antenna. We already know our antenna should be as vertical as possible in order to maximize vertically polarized radiation, and that our antenna will be electrically short. This recipe suggests a particular type of antenna, the quarter-wave Marconi. Probably ours will be shorter than a quarter wave. What will this do to our equivalent circuit?

It will make R_c smaller since the current is flowing in less conductor, and it will reduce R_r because our coupling to space is less complete. See **Fig. 9**. The shorter current path suggests L_e will be reduced, and so will C_e, but we can see that C_e tends to predominate since the shortened antenna is approaching a capacitor configuration.

Our shortened Marconi will have reduced radiation resistance compared to a quarter-wave Marconi, and its reactance will be capacitive. We will want to put a loading coil in there somewhere, and our feed system must feed a resistance which may be much lower than the 50 to 300 ohm values we typically expect on the higher frequency bands. When we are facing up to an uncertain situation, what do we need? We need to be able to make good measurements.

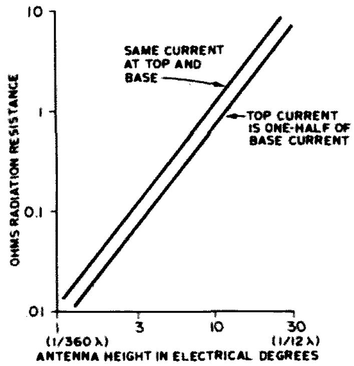

Fig. 9. Use this chart to estimate the radiation resistance of your antenna before you commence construction.

160 Meter Antenna Test Gear

On the higher frequency bands you can set up a cookbook antenna and tune your system with an SWR bridge. Perhaps you can get by on 160 using this approach but I wouldn't recommend it. What if you get a poor swr and your adjustments do not seem to be effective? Then you must proceed blindly, and that is no way to enjoy a bright Spring day. You need an SWR bridge in normal operation but until you have determined what adjustments are "normal" you should have a grid dip oscillator, and some kind of *rf* resistance bridge.

The GDO can be built, borrowed, or it may come along with direct assistance from a friend who already has one and who is interested in your 160 meter antenna project. His views will be different from yours, and this diversity of opinions can be very helpful when dealing with some knotty questions arising from antenna work. But don't tell him he is a part of the project's test gear.

Since *rf* resistance bridges are quite rare you can expect to build your own. It can get its *rf* power from the GDO. The circuit of **Fig. 10** is discussed in detail in "How To Hang a Dipole," in the May 1968 issue of 73 Magazine, and so it gets pretty light treatment here. The present version is optimized for 160 meter antenna work, where resistances will typically be quite low.

Basically, this is a Wheatstone bridge, or a resistance comparison bridge. You will get some meter reading when applying *rf* to the

input loop, and the reading falls to zero when the LH side and the RH side act as resistive voltage dividers reducing the applied *rf* voltage in the same ratio.

This situation arises when the antenna terminals present a purely resistive connection, since the adjustable resistance has negligible inductance or capacitance, and when the variable resistance is adjusted to the same value.

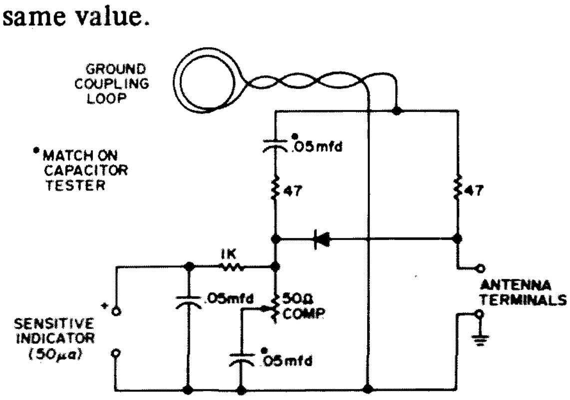

Fig. 10. This simple bridge circuit will measure antenna input resistance at resonance. Remember tolerances on capacitors are commonly very loose. A capacitor checker can do an adequate job of matching.

If you want to put this into a box it makes a handy item, once each year or so. A breadboard assembly, or simply soldering all connections and moving things gently will get you by, and to determine the result of your test you unhook the pot, after nulling, and measure its resistance with a low-range ohmmeter.

Your procedure in applying this gear is suggested by the equivalent circuit of Fig. 8. The best approach goes in two steps. First, you determine the antenna's resonant frequency by dipping it at a high-current point to discover its resonant frequency. Probably you merely add a couple of turns of wire for a coupling loop at the input terminals, and couple in the GDO to this loop. If antenna tuning is indicated, you bring the resonant frequency up or down by appropriate loading coil or capacitance adjustments. And then you apply the bridge to measure the antenna's input resistance, *at the same frequency.*

Since the antenna may have a very low input resistance, you may change its design or use a transformer matching system to increase the input resistance. In this case the *rf* bridge comes into play again to establish that your work has had the intended results. If a certain arrangement was supposed to increase a five ohm input resistance to 60 ohms, and you get a good null with a 60

ohm bridge setting then you know you have achieved your goal. You will be using your antenna while the fellow with only an SWR bridge is still running around with wires, insulators, pulleys, etc.

160 Meter Antenna Construction

Now we are about ready to put up a shortened Marconi antenna. Where will we put it? Since we can place it wherever convenient, it does not need to be very close to the transmitter. In fact, we want it at least a few feet from the building to reduce energy wasted by coupling into house wiring. The possibility of TVI is reduced too.

Having chosen our site and identified a few places where we can attach the top portions of the system, we might make up a sketch something like **Fig. 11**. There is very little detail since we already know about what is available to work with. First we turn our attention to the ground connection.

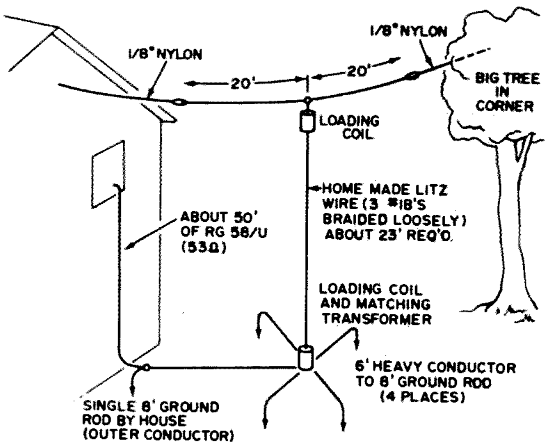

Fig. 11. Ballpark estimate of a real antenna somebody might construct for 160 meters. Note generous grounding.

Because the antenna's radiation resistance will be low, we must have an excellent ground. That could be the subject for another article, but it's basically simple and is well treated in many handbooks. The key points when making a good low-resistance ground are lots of surface contact, and possibly some assistance from chemicals. Remember salt and copper sulfate are plant poisons and may be carried out by ground water to do damage some distance away.

Now, with the ground established, we are ready to start setting up our antenna. The flat top goes up and pulls the vertical portion with it. There is no loading coil, yet. With everything in approximately its finished location we really have a full-scale mock-up of our antenna and we are ready for some cut-and-try adjustments. Careful notes and records will help.

Probably the system resonates at too high a frequency. After determining what the resonant frequency actually is, we let the top down and add a loading coil of, say, 20 microhenries. Pulling everything up again, we measure the new resonant frequency, which will be lower. This gives us two points on a graph of frequency versus loading inductance, and we plot this variation assuming a straight-line relationship to choose a new inductance.

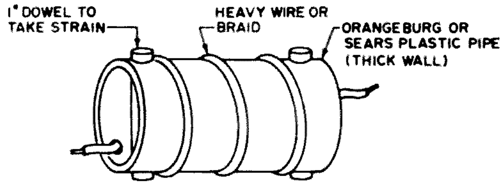

Fig. 12. Sizable loading inductances can be assembled easily from materials available around the house, from Sears, or an Agway farm store.

These three tests should give us an excellent idea of the loading inductance required to bring the resonant frequency down to 2 MHz. Ideally, we want to resonate the system to the top of the 160 meter band, or slightly above that, since we can make final adjustments at the bottom of the antenna without appreciably reducing its effectiveness. We make up appropriate rugged transmitting type inductances, perhaps from #16 vinyl-insulated Sears-Roebuck wire on a piece of Sears plastic sewer pipe as suggested in **Fig. 12**, and assemble the finished antenna.

A final test establishes that we have done the job in a sound workmanlike way, and we wind up with a finished antenna that looks something like **Fig. 13**.

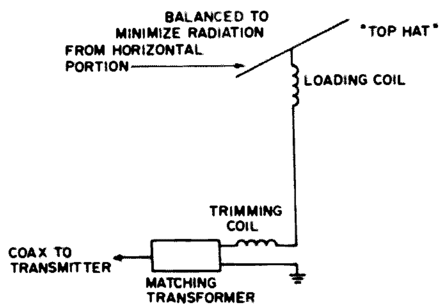

Fig. 13. Electrical appearance of the finished antenna.

Try your understanding of the principles on the two other antenna designs of **Fig. 14** and **Fig. 15**. These are borrowed from the Radio Handbook where their operation is

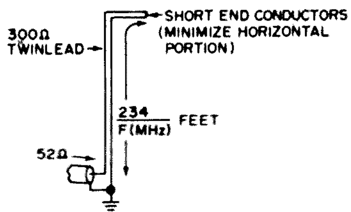

Fig. 14. A simple single-band vertical borrowed from the Radio Handbook. It would have to be around 130 feet high on 160 meters. Check as described in this article, before using.

described in detail. They incorporate two schemes for increasing a low input resistance, and the antenna of Fig. 15 also has a top-loading effect which operates to resonate the system on the lower frequency band.

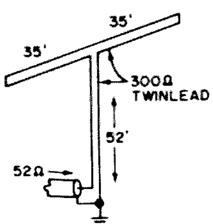

Fig. 15. A two-band antenna, known as the "Multee." Efficient design workable on two bands, such as 160 and 80.

Matching Into 160 Meter Antennas

A 50 or 75 ohm coaxial cable is said to be properly terminated if it feeds a 50 or 75 ohm resistive load. Referring to Fig. 8 again, we see that if the inductive and capacitive reactances are equal the load must be resistive. We guarantee this by checking and adjusting our antenna to resonance at our intended operating frequency. But, looking at Fig. 9 we see our shortened Marconi will probably have a radiation resistance considerably lower than appropriate for the kind of system we would like to use for feeding it. What can we do to improve matching?

A trivial answer is that a series resistor will make up the difference. A 5 ohm R_C plus R_r with an added series 47 ohm resistor

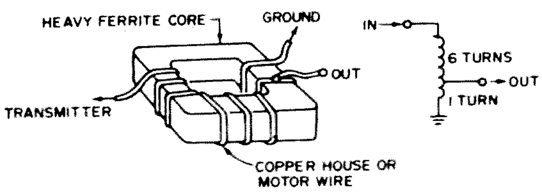

Fig. 16. At RF, a matching autotransformer is not hard to make. Remember the lower end of the coil, inside the antenna tap, will carry a much heavier current than the upper end. A two-winding transformer will work equally well and could avoid mixing wire sizes on the same winding.

makes up 52 ohms, just right for feeding by a standard coax cable. We'll have a matched system, and it won't be worth peanuts.

We can do much better with a nonresonant matching transformer. If you can do it at audio why not *rf*? Imagine we want to match a radiation resistance of 1 ohm up to a 50 ohm cable. We see how to do this in Fig. 16. A 7:1 turns ratio will achieve a 49:1 resistance conversion, just what is required. And if we apply a few simple facts about transformers we can determine that our system actually performs as intended.

Our key to sensible tests is that if the transformer is doing its job it will transform a short into a short. That is, our antenna should act the same with its input shorted as with the transformer input shorted. Checking the system's resonant frequency under these two conditions will establish this point.

Once we know the transformer is transforming, we check the system input resistance, looking at it through the transformer to establish that our input is really resistive. Finally, an on-the-air test shows the transformer does not get very warm, indicating core losses are not excessive. Just to make sure, perhaps we check for harmonics or observe the transformer's operation with a scope to discover if the core is going into saturation and generating interference. This is very unlikely. Once we have performed all these tests we have about covered the field, and if we have done mechanically sound work our system will be reliable.

To understand another way of matching the antenna's low radiation resistance, let's suppose we have a vertical antenna that accepts 1 ampere at 20 volts, at resonance. See Fig. 17. Now, we split this antenna in two, and feed only one side of it. Since each side carries half the current we feed only one-half ampere into it. But then we will have to double the input voltage, in order to radiate the same power. The effective input resistance, E_{in}/I_{in}, has increased by a factor of four. If we split the antenna three ways we could step up the effective input resistance by a factor of 9.

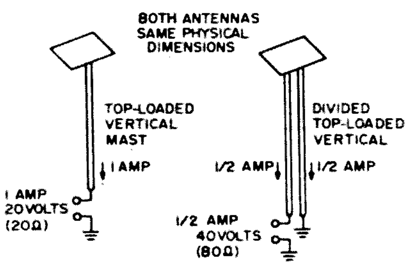

Fig. 17. How to get something for almost nothing. Splitting the vertical increases the input resistance by a factor of four. This is the idea behind the antenna of Fig. 14.

Perhaps that seems strange. But this is the same system used on the higher frequency bands, where a dipole may be divided into two parallel conductors of unequal size, and only one is fed. You see this in Yagi construction. The unequal size acts in the same way as the uneven division of fed and unfed conductors. This arrangement serves in the Radio Handbook antennas shown in Figs. 14 and 15.

Finally, we can go to the VLF engineer's trick of using several downleads. This works in the same way as the split-conductor method, but it is more elaborate. See Fig. 18.

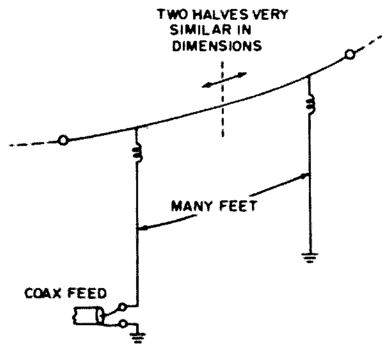

Fig. 18. The idea of Fig. 17 can be used very practically in a more extreme form. Testing and adjustment is more difficult, but this is the way the Navy builds its huge VLF antennas.

Here we have two "downleads", for an apparent radiation resistance stepup by a factor of 4. Since each downlead carries half the capacitive current surging between ground and the horizontal top conductors, ground is less critical. To tune this one imagine each downlead gets half the available top capacitance. Then the inductance per downlead must be twice that of a single downlead, with equal inductance for each downlead. Imagine a commercial engineer setting up a hugh VLF system with several downleads, if you like. I'd rather not! But it is a way to get efficiency from a system that would ordinarily offer high losses.

VLF engineers can get workable efficiencies from antennas for wavelengths in the order of a million feet. Now that mere 530 feet doesn't look so bad after all, does it? So get out there and enjoy that Summer weather while you get your new antenna established.

...W1EZT

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The Triac

Theory and Practical Application

To many of us in amateur radio, "state of the art" is a phrase which conjures up visions of complex solid state circuitry as well as a rapidly diminishing bank balance.

Many a writer, moreover, while professing the simplicity of his brain child, fails to accurately evaluate the contents of his meager junk box. Mine, for one, is truly a poverty area. That 50 mH choke that the author plucked from an old chassis came into my possession as a result of a cash outlay of $1.98. The common 2N4012 VHF transistor set me back $24.00, plus shipping costs.

Having read this far you undoubtedly now assume that I will reveal to your bloodshot eyes a project involving little more than hairpins, razor blades and hookup wire. Sorry to burst the balloon, OM.

Resign yourself to the inevitable. Prepare to wring a little more out of that threadbare wallet. This little gem will cost you—but it will save you quite a bit also.

A Variac is a very useful item around the shack. It will regulate the speed of your drill, run up the B+ on your KW rig, slow down the electric fan or dim the living room lights. The limiting factor is expense. A Variac with a current rating large enough to do a big job often carries a price tag of up to and over $100.

Here then is the story behind an electronic Variac that will handle a full 6 amps of ac current, will operate any kind of electric motor, and will cost a mere $5 worth of components.

What makes this all possible is a recent device which made its debut on the solid state market only last year. Its name, the triac.

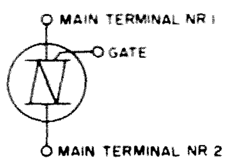

Fig. 1. Symbol for the triac.

The triac is a type of Thyristor, a device having characteristics similar to those of the thyratron tube. Fig. 1 shows the schematic symbol of a triac.

This three lead package basically consists of two 4 layer semi-conductor structures placed back to back. The layers are composed alternately of P and N type material (Fig. 2).

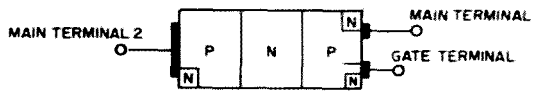

Fig. 2. Internal construction.

The electrodes are the Main Terminal 1, Main Terminal 2 and the Gate or control electrode, analogous to a thyratron's grid.

Where the silicon control rectifier, a common thyristor used in light dimmers, is only capable of half wave operation, the triac will provide symmetrical bidirectional control (Fig. 3). It is thus usable with any type of ac electrical load where the SCR control is usable only with ac-dc type devices.

The operation of a triac depends upon three values. These are forward breakover voltage, holding current and gate signal.

When either diode in the triac is forward biased (the anode positive with respect to the cathode), it may either present a high or low impedance to the circuit depending upon the potential applied. The triac will conduct very little until its forward breakover voltage is reached. At this point it will switch to the on state and conduct heavily, presenting a very low impedance to the circuit.

As an applied ac voltage becomes more positive (Fig. 3), little current will flow until the breakover value of voltage is reached. At this time the triac will switch on. As the voltage drops to zero, a point is reached at

which there is no longer sufficient "holding" current flowing to sustain the triac in its on state and the device will turn off, ceasing to conduct.

The alternating voltage now makes its negative excursion and once more there is no current flow until the breakover point is arrived at.

As seen in Fig. 3, the triac acts as a switch turning off during a portion of each ac cycle. The effect of this switching action on a load powered by this circuit is much the same as of a Variac. We can effectively reduce the available power to the external device.

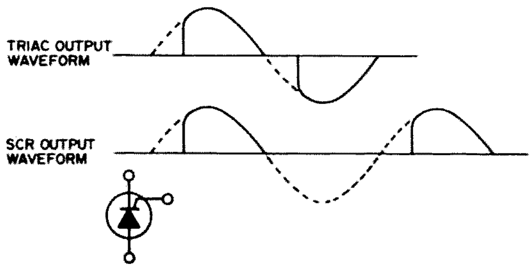

Fig. 3. Silicon control rectifier vs triac.

To vary this switching action is the role of the Gate lead. When there is no voltage applied to the gate, the main terminal voltage must reach the breakover value ($V_{(bo)}$) of the device before current will flow. As Gate voltage and thus Gate current is applied and increased, the $V_{(bo)}$ level is decreased causing the triac to conduct earlier in the ac cycle.

In a practical circuit, the triac is operated far below its breakover voltage and is triggered–at any voltage level desired–by a gate signal large enough to assure that the device will turn on.

Once in the conducting state, the triac, independent of its gate voltage, will continue to conduct until the terminal voltage and current fall to below the holding value.

The circuit shown in Fig. 4 utilizes a neon lamp as a triggering device. The object is to obtain a pulse of current which is variable in frequency and can therefore be used to trigger the triac into conduction at any portion of the ac cycle.

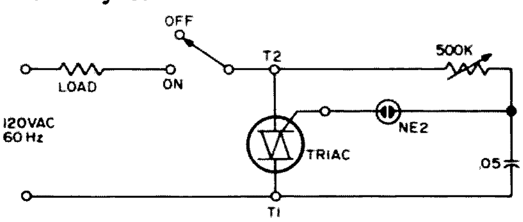

Fig. 4. Single time constant circuit with neon bulb trigger.

A neon bulb is bilateral; will conduct equally well in both directions, making it a natural for triac operation. On each half cycle, the capacitor is charged through a potentiometer, its rate of charge or RC time constant being determined by the setting of the pot. When it reaches the firing point of the neon bulb (about 50 volts) it discharges through the bulb and the triac gate lead, turning the triac on. By varying the value of the potentiometer, the turn on point of the triac is varied and thus the load receives more or less power from the line.

Neon triggering has a number of disadvantages, however. When used with a common 120 vac line, a voltage loss of up to 10% may result due to the relatively high firing point of the bulb. Also, radiation acts to lower the firing potential, causing the circuit to become unstable.

A more satisfactory arrangement can be realized through use of trigger diodes. These are solid state equivalents of the neon bulb. We need not delve into the realm of solid state triggering, however, since the semiconductor world has simplified the job by building and marketing a triac having its own integral triggering device. A number of these are available on the market with a price tag in the neighborhood of \$3.00. Such a device is the RCA 40431–a little beauty which will handle up to 6 amps when operated with a proper heat sink.

The circuit (Fig. 5) is of such simplicity that the entire complement of parts may be mounted directly on the terminals of a potentiometer. A double time constant circuit was chosen to avoid the "quick turn on" effect of a single time constant circuit. The triac is kept in some degree of conduction at all times so that a smooth turn on is facilitated.

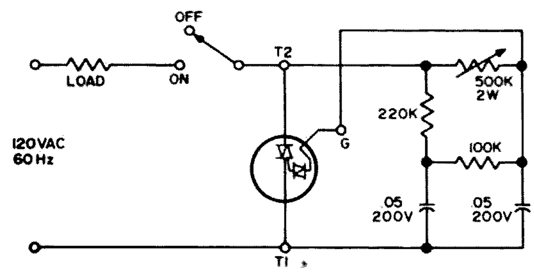

Fig. 5. Double time constant circuit with internal trigger.

In construction of this device, it should be remembered that the triac must dissipate quite a bit of heat. After some experimentation, I have found a Wakefield NC-303K heat sink excellent for this application. A .335 inch diameter hole should be drilled in one end and the triac press fitted into it.

The heat sink will have line voltage applied to it during operation and should be placed in such a way that it will have adequate room for heat dissipation yet not be touched. It is recommended that the sink be mounted in the vertical position so that convection air currents will cool it most efficiently.

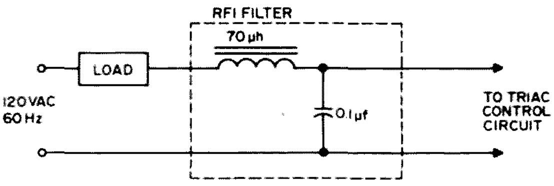

Fig. 6. RF interference filter.

When the triac control is used for operation of an electric tool or lamp, no filter is necessary except if undue interference is experienced in nearby radio or television receivers. For such cases a line filter should be used.

I have made use of the device for control of the speed on a drill, lamp dimming and as power supply control, all with great success. Have a ball OM and amaze the gang with your $5.00 Variac.

...K8TSQ

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430 - 470 khz Sweep Frequency Generator

Here is a simple sweep frequency generator for aligning the most common *if* strips. The unit has only one transistor because the sweep voltage is taken from the oscilloscope it is used with. Most general purpose oscilloscopes have a sawtooth output jack. By using this sawtooth, the frequency is locked to the position of the trace.

The oscillator is made to deviate in frequency in step with the voltage applied to the base bias circuit, either the sweep voltage or the dc voltage applied at the control point. If no sweep or control voltage is applied, the oscillator runs at the center frequency, and may be used as a conventional signal generator.

The 2.5 mh choke and the two 150 pf capacitors form a very broad tank circuit, so it is easy to FM the oscillator without a great change in amplitude. As to how the change in base voltage causes the frequency shift, I am not quite sure. All I know is that it is quite linear and is a positive shift (Fig. 3). That is, an increase in base voltage causes an increase in frequency. Also, a change in collector supply voltage will shift the frequency, so be sure to use a stable supply.

Since an rfc is used as part of the tank, you may have to compensate for a variation in center frequency by changing the 150 pf capacitors to some other value to get 455 khz as your center value.

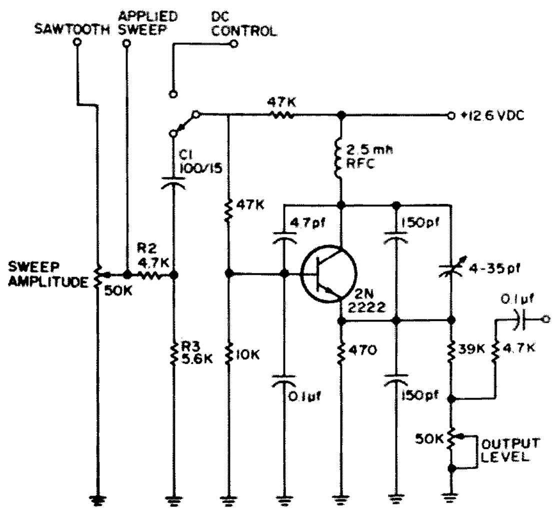

Fig.1. Sweep generator circuit diagram.

If you do, then run a plot of dc control voltage vs frequency and adjust the voltage divider R2 and R3 so that 1 volt P-P at the sweep pot wiper gives plus and minus 5 khz (10 khz total). This is not as hard as it sounds. Just listen for the harmonics on a broadcast band radio. For instance, the second harmonic of 430 khz is 860 khz, and the second harmonic of 470 khz is 940 khz, both handy on the BC radio. Note the dc voltages at the control point required to obtain these frequencies. Take the difference and divide

by four. The answer is the P-P voltage required to shift the oscillator plus and minus 5 khz. Then apply a low, known ac voltage to the wiper of the sweep pot with the switch in the *sweep applied* position. Adjust the value of the divider resistors to get the proper fraction. In my case it was 0.43.

It is advisable to run the sweep rate as slowly as possible, in order to display the response curve as accurately as possible. The sharper the skirts, the more slowly the generator must pass through the bandpass. With this generator, the amount of frequency deviation is controlled by the P-P amplitude at the sweep pot arm. If you are looking at the response of a regular *if,* you would set the sweep amplitude high to see the entire response curve. As far as an accurate display is concerned, this is fine, since the slope of the skirts is shallow. But if you were looking at the response of a sharp filter, you could not tolerate such a wide sweep, because the fast rate-of-change would tend to skew the display. To correct this, reduce the sweep amplitude to reduce the frequency deviation down to the edges of the skirts of the response curve. This reduces the rate of change and minimizes the skewing of the display. Also, it is better to display the *if* before detection, if possible, to prevent the detector time constant from possibly distorting the display.

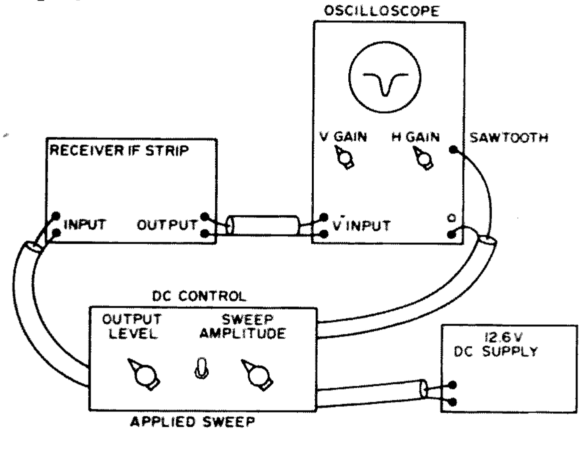

Fig.2. Interconnections of sweep generator.

If you have the sweep generator set up as described, then it is easy to set the sweep for a known deviation, and then procede to read the 3 or 6 db points from the face of the scope. Be sure to disable the AGC for this test.

For those who aren't familiar with the set-up for obtaining the response curve display, refer to Fig. 2. and the following outline.

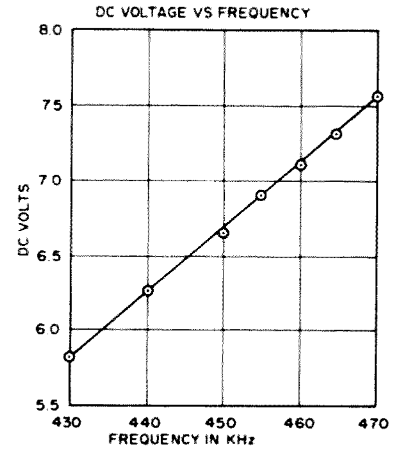

Fig.3. Sweep frequency vs dc voltage.

DC CONTROL VOLTS	FREQUENCY
5.86	430
6.27	440
6.69	450
6.90	455
7.12	460
7.33	465
7.55	470

First, hook up the equipment as in Fig. 1 Set *horz gain* for desired sweep width. Adjust *sweep amplitude* pot on generator for desired frequency range. Set *output level* to mid-range. Adjust the *vert gain* for the desired pattern height.

If we wish to change the total frequency deviation and the horizontal display width at the same time, use the scope's *horz gain* control. This presumes that the amplitude of the sawtooth output is also varied by the *horz gain* control.

If we wish to change the frequency spread and not change the width of the scope display, adjust the *sweep amplitude* control. This allows you to take a better look at the sidelobes or any ripples in the passband, depending on how the controls are adjusted.

You don't have to use a sawtooth to sweep with if it isn't handy.

Sixty hz can also be used, but it will probably skew the passband you are trying to display, so I don't recommend it. One note here: when the sweep generator is first turned on, or the setting of the sweep amplitude is changed, the frequency will drift for a few seconds. This is due to the charge on CI changing to a new level. CI is large to couple the low frequency sweep with as little distortion as possible.

...WA5SWD

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What Do You Think?

Truth stranger than fiction has been the subject of several very interesting QSO's in which I have participated in the last few years. In most cases the ham relating his experience has mentioned "the long arm of coincidence." In the true story which follows I leave the decision to the reader; was this coincidence or . . . ?

On the 30th of October, the weather man on WBZ-TV mentioned that there might be an aurora during the evening because of a solar flare the day before. To those hams who are familiar with the phenomenon and results which may be experienced on six meters, the announcement of a pending aurora is an invitation to warm up the six-meter rig and turn the beam into the north.

It had been sometime since I was last on six; I therefore welcomed the opportunity to fire up the rig in "studio B." To my disappointment, the familiar noises accompanying the aurora were not to be heard. However, I tuned across the band and very near 50.4 mhz discovered the voice of an old-timer signing his call after a short test. W1KKB, Louie, after many years of operation in Everett, Massachusetts, moved to Exeter, New Hampshire. I gave Louie a shout and was not surprised when he returned my call. After the usual informal opening remarks during which Louie chastized me for not reminding him of our recent ham get-to-gether at Moody Beach, Maine, which has been held on an annual basis for the past three years, he gave it back to me. I apologized for overlooking an invitation to KKB and remarked that this year the preparations and invitations were mostly left hanging until the last moment. I pointed out that we sorely missed John, WA1ANK, who had arranged for mimeographing the announcements the year before and had greatly assisted me in the mailing and in alerting all hams whom he had contacted by radio.

It was while we were on vacation on the second Wednesday in July this year that the XYL, Bette, received a phone call at the camp informing us of the death of WA1ANK. He, Johnny, had come home from his office early in the day feeling quite ill, but as was his custom had turned on the Swan 250 and was in QSO with Joel, K1MUE, in Mason, New Hampshire, He failed to respond when his turn came around again and was sitting there in his chair when Dottie came home for lunch.

We all loved John on six meters and he had literally thousands of ham friends on two and six. He would get on in the contests to help others get their points, and assisted in setting up the hilltoppers in preparation for the VHF contests. He was kind, courteous, and above all, a friend to all. Louie confirmed my remarks concerning Johnny and mentioned how much he missed the days when either from home or mobile rig WA1ANK could be heard in the thick of the six-meter activity.

It suddenly occured to me that I had an appointment, and that I had best sign shortly; I said as much to Louie and was winding up the QSO when it passed through my mind to say to Louie that if Silent Keys could listen in and read the mail, surely John would be right in there. Then as I was about to sign . . . the rig went off the air, the receiver became silent, and the blower on the 4 x 150A spun to a stop.

At first I imagined I had lost a fuse in the modulator-power supply unit. After fumbling around for a slowblow fuse and just as I was about to replace it, I noted that with the rig out, the receiver gone, and the fan disabled, the trouble must be at the main fuse box.

Opening the cover on the box, it was not

at once apparent which of the two fuses had blown. I turned on the low frequency power switch in "studio A" and removed a fuse until the low band rig, light and all, went off. Quickly I placed the now proven "good" fuse in the other fuse socket and the power returned to "studio B." I reexamined the nonworking fuse and still saw nothing wrong with it. It was one of those known as a *fustat* plug and had been put in the switch box early in 1967. Then I remembered; because of the great line voltage drop I had been experiencing since we had moved to Andover from Boston, I had hired W1HTY, Bill Howarth, a professional electrician, to run two separate lines from a new switch box.

This was the first trouble I had had since the installation. Bill, W1HTY, died a year ago last August, again, while I was on vacation.

(Our friendly supplier who sold me some replacement *fustats* examined the nonfunctioning fuse and then asked me what was wrong with it. I could only say that I believed that John, and Bill, two Silent Keys, good friends from Andover and North Andover, respectively, were the only ones who really knew what was wrong with that *fustat.*)

When I finally got the rig back on the air, Louie was still on frequency talking to WA1IVT, Mel, and WA1ELZ, Ed, of Methuen, both of whom had been reading the mail when my rig suddenly went off the air. Louie said, "Let's see if Father Bob has his rig back on the air." I turned on the power and explained to the fellows that my troubles were not serious but were not really of this world. What do you think?

. . . K1OXK

Eliminating Hand Capacity

Most experimental circuits are tried out "bread-board" fashion. Hand capacity effects can be troublesome, especially at the higher frequencies. In order to minimize hand capacity effects the following gadgetry was devised. The adjustment screws in trimmer capacitors and slug-tuned *rf* coils is fitted with a flat piece of tin, securely soldered into the slot. Then it may be adjusted with a long hollow tube of plastic or hard rubber which has been slotted at one end for this purpose. This idea may be used to improve the alignment of any piece of electronic equipment, "home-brew" or factory built.

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Leaky Lines

To all of you who served in the Army during World War II as I did, it won't be necessary to explain the term "latrine lawyer." Those who have no first hand acquaintance with this ubiquitous character may know that he is someone who knows everything about everything. He doesn't mind telling anybody within earshot exactly what to do, when and how to do it, and why. If you dig beneath the superficial veneer of this specimen, you will find a faker and charlatan, possessing what Oscar Levant once called a smattering of ignorance. Armed usually with only the sketchiest sort of information, he expands it with a tenuous structure of half-truth, innuendo, rumor and implication. He will fasten onto you like Sinbad's old man of the sea, and will never let you go, haranguing you till your ears ring. The inexperienced, the meek and the gullible; these are his "pigeons." He is one of nature's true phenomena, first, last and always, a phoney!

Ham radio is not immune. We, like the Army, have our share of "bathroom barristers," who may be found, holding forth on the airwaves, counseling all their starry-eyed admirers. Impressionable beginners, ingenuous and naive; more mature persons with fancied grievances and gripes; the inarticulate and prejudiced seeking a voice; misfits who revel in divisiveness; all these gather around his feet, drinking it all in.

There's just one fatal flaw in this idyllic scene. The guy doesn't know what he's talking about. It's all a mish-mash of misinformation, without a scintilla of creditable fact to back it up. Here are some common examples of his hogwash.

"I wouldn't use an electronic keyer for all the rice in China. They make everybody sound just like a tape machine. Why, you lose your identity completely. Give me the good old bug every time."

What hokum! There's more bad sending on bugs, side-swipers and cootie keys than you can shake a stick at. If a banana-boat swing is supposed to be a mark of identification, it escapes me. It doesn't make for individuality of fist, as much as it demonstrates little or no concept of the sound of true CW. Moreover, characteristic individuality of spelling, punctuation, word usage and other unique peculiarities are maintained regardless of the sending instrument. What we need are more electronic keyers, not fewer. Perhaps this would clear up some of the horrendous stuff that's been passing for CW for a long time. In any case, it would help diminish that atrocious syncopated swing, and reduce it to a passably tolerable minimum.

"I'm not interested in having broadcasting quality audio. What really counts is communication. That's the name of the game. Boy, when there's a pile-up, I just crank up my Whatziss Mark III, and turn the gain wide open. I like to watch those needles jump. Then I know the DX station is going to copy."

Yes, and so will everyone else within twenty khz, plus or minus. What can I say about this guy, except that essentially he's just a pig who doesn't consider other people's rights at all. His trademarks are over-modulation, audio distortion, flat-topping, unwanted hash and spurious radiations, and an abusive attitude toward anyone who tries to suggest that he cut back on his gain a bit. Brother, how wrong can you be?

"You guys are not on frequency. I'm crystal controlled, so I know I'm on frequency."

Not a single word about whether that crystal is in an oven. No mention of the associated circuitry, the trimmer capacitor. No awareness that the crystal may be pulled quite a few cycles by manipulation of the

tuning condenser. Nothing about voltage regulation, which, if poor, can put that crystal right outside the ballpark in nothing flat. But no! This character makes his unequivocal statement, and all the little shrinking violets let him get away with it, even though they know far better, simply because they don't want to fall into his big mouth. So, he gets by without a challenge.

"You don't have to worry about SWR. Anything less than four to one is okay. Don't worry about reflected power or standing waves. Lookit. If conditions are lousy, sunspots, aurora or wrong skip, you aren't going to get through, even with a kilowatt. And if conditions are right, they'll copy you on a wet noodle. So why worry about getting a unity match? Forget the SWR."

Great, isn't it? I really don't care about him. In fact, maybe we'll get lucky and he'll burn up his final, and we'll be rid of him once and for all. It's too bad that so many gullible people will go along with him.

"I have it on good authority that incentive licensing will never go through."

Does that sound familiar? It ought to; we heard it so often for a couple of years. It was stated with fervor and conviction. It reminded me of the scared kid, whistling while taking a shortcut through the cemetery. These guys were so adamantly set against the re-structuring proposals that they couldn't imagine that anyone would disagree with them. Many of us were against incentive licensing, that's true. But, when it became a fait accompli we simply rose to the challenge, and started to prepare ourselves to meet it. The same jokers are now saying something like this:

"I have it on reliable authority that the FCC is going to take a long, hard look at this fiasco, and is going to refuse to implement the second year sub-band allocations. It just hasn't worked out the way they hoped."

More wishful thinking. They would rather stew in their own venom than come to grips with the obstacle, and exert themselves in order to overcome it.

Here are a few more, about which I will not comment. I leave it to you to draw your own inferences concerning my feelings in the matter.

"What do these nets think they're pulling, anyway? They don't have any right to tell me to move. I've got just as much right on this frequency as they have, and if they want a clear channel, let them use the telephone."

or. . . .

"I listened on this frequency and didn't hear a soul. Just because you claim to be running overseas phone patches doesn't entitle you to take over the whole band. Did the FCC give you this channel exclusively, or something? Boy, a guy comes home after a hard day at the buttom works, looking for some relaxation, and right away some do-gooder tries to push him off the air. I tell 'em nuts. Every time."

or. . . .

"Whaddye mean, I'm on the DX station's frequency? Let him go down to the foreign portion where he belongs. If I feel like working here, it's my business, and if you don't like it you can lump it. It's a free country."

And so it goes, on and on, far into the night. How about this one:

"I didn't copy that last transmission, Mac. Some lid interfering deliberately. He was testing on this frequency before we started, and I'm sure he heard us. But he's still testing. I don't know what's happened to good, old-fashioned courtesy, anymore."

or. . . .

"Take it from me, Charlie, all these here appliance operators with the sideband gear are making a shambles outa this hobby. I've been using this receiver for over twenty years, and I never had any trouble before these quack-quackers came around. They're all over the band, broad as a barn door. Whaddye mean, a product detector? I never needed one of those when a good AM signal came through. And don't tell me about the selectivity, either. This receiver of mine has been doing a great job for me, and I'm not about to modify it just because of a bunch of Donald Ducks. Sooner or later this sideband stuff is gonna fade right outa the picture, anyway."

Well, I just thought I'd get it off my chest, anyway. Anyone for tennis?

. . . K2AGZ

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Magikey – for Automatic Didahs

Flat-walleted brass-pounders, take heart. An electronic key, the Magikey, is a gutless wonder for making self-completing dots and dashes with controlled spacing. Only three plastic transistors are used to generate the keying waveform, and the lot can be bought for about two dollars. A keying relay and driver are available for about another three bucks if you need them, and the single pole key can be anything from a "Vibro-key" to a piece of hacksaw blade.[1] Don't let the cost or size mislead; it's a real performer, almost like magic.

The Magikey uses the Programable Unijunction Transistor (PUT) to develop the timing function and keying waveform. The PUT is a peculiar device introduced by GE a little over a year ago. The PUT exhibits a negative resistance between anode and cathode whenever the anode-gate junction is forward biased and a critical anode current, Ip, is permitted to flow. That is, after the anode is made more positive than the gate, the regeneration inherent in the PNPN structure causes the anode-cathode and gate-cathode voltages to drop to less than a volt above cathode voltage. The device remains "on" until the anode current is reduced below Iv. After the anode current is reduced below Iv, the device turns "off", and the anode cathode terminals become essentially an open circuit.

The ratio of Ip to Iv can be from 5 to 50, depending on the gate voltage source resistance. The highest ratios seem to occur when the source resistance is in the range from 10K to 100K. The lowest ratios occur when the source is in the range of 1K.

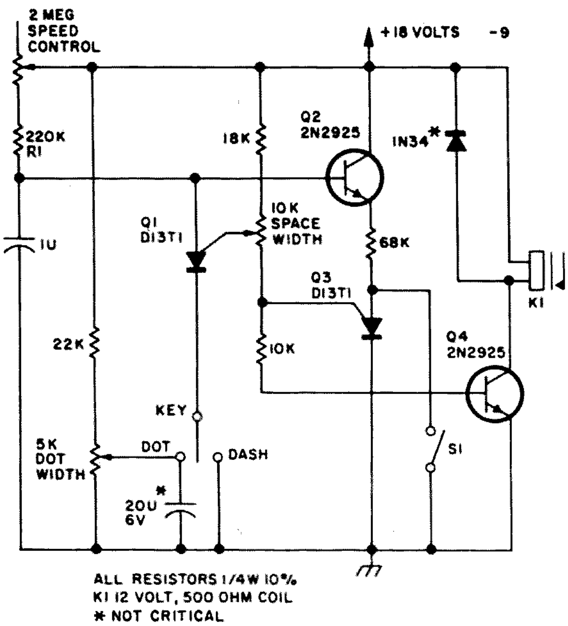

Fig. 1. Magikey electronic key schematic diagram.

The Magikey, shown schematically in Fig. 1, can be divided into three parts: the timing section, Q1; the keying waveform generator, Q2 and Q3; and the keyer, Q4.

The timing circuit basically is a UJT relaxation oscillator. When the cathode is grounded, it operates as follows: The timing capacitor, C1, charges through the speed control R1, and the PUT anode voltage rises at a rate determined by C1, R1, and the supply voltage. R1 is chosen so that its

current is greater than the Ip of the PUT but less than Iv for all conditions. When C1 has charged to the gate voltage, Vg, the PUT turns on and discharges C1 to about cathode voltage. After C1 has completely discharged, the only current available to the anode is through R1. Since this is less than Iv, the PUT turns off. The capacitor then begins to recharge to repeat the cycle.

The anode voltage of the PUT, then, is a sawtooth with the maximum positive voltage approximately Vg, and the least positive voltage approximately equal to cathode voltage. When the cathode circuit is open, the anode voltage rises to Vg and is limited there by conduction of the anode-gate junction, and oscillations are interrupted. As soon as the cathode circuit is closed, C1 discharges to cathode voltage at a rate determined by C1 and the impedence in the cathode circuit. In the circuit given, any closure longer than 1 ms is enough to allow C1 to completely discharge.

To generate dash timing, the cathode is closed to ground and C1 discharges to about 1 volt. The time required for C1 to recharge to Vg is equal to the time of a dash and a space. To generate dot timing, C1 is not closed to ground but to a positive voltage, so that the time required to recharge to Vg is reduced to that of a dot and a space. The sawtooth pattern for the word "an" is shown in **Fig. 2.**

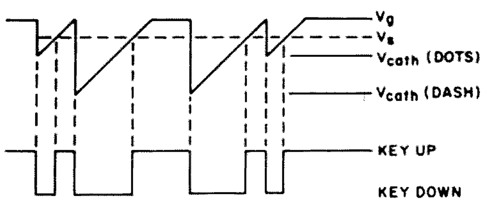

Fig. 2. Keying waveform for word "AN."

The keying waveform shown in Fig. 2B is generated by sensing whether the sawtooth voltage is above or below a particular voltage Vs. When the sawtooth is more positive than Vs, a "key-up" voltage is produced. When the sawtooth is less positive than Vs, a "key down" voltage is produced. The time required for the sawtooth to rise from Vs to Vg is the time of a space, or the minimum "key up" time that can be generated.

In the keying waveform generator section, the PUT, Q3, does the voltage level sensing, while Q2 isolates the timing capacitor from the loading effects of Q3. When the voltage on the emitter of Q2 is higher than Vg of Q3 and causes Ip to flow

through R4, the PUT turns on, and the anode and gate voltages fall to about 1 volt. This voltage level represents "key up." When the voltage on the emitter of Q2 is reduced, (the timing capacitor is discharged), the anode current available to Q3 is less than Iv, and the PUT turns off. The voltage at the gate of Q3 switches from about 4 volts "key down" to 1 volt "key up." This is more than enough to drive a keying transistor or even a low-power audio side-tone generator.

In the keyer section, Q4 is the keying transistor. The "key down" current varies with power supply voltage, from .25 ma with a 12 volt supply, to .5 ma with a 24 volt supply. This current is sufficient to drive a low current transistor. In **Fig. 1**, the keying transistor is shown driving a keying relay, but the most practical and economical approach depends on the keying arrangement used in your transmitter. A high voltage transistor costs about half as much as the relay, but has limited current carrying capability.

When driving a relay, the power dissipation in the transistor can be very low. The dissipation is less than 75 mw when driving the 500 ohm coil, as shown in **Fig. 1**. The problem is not dissipation; it's the inductive kick when the transistor turns off. The diode across the relay eliminates that problem, so that a low voltage transistor can be used to drive the relay. The diode does extend the relay release time, but it should be significant only if you're batting along at 30 wpm or so. You won't be working me, though, at those speeds, so I'm not too picky. If you are, use a high voltage transistor that can stand the kick.

The circuit given has a keying speed range from about 5 wpm to 50 wpm. If this is a greater range than you need, you can rejuggle the R and C combination in the timing circuit. Just keep the total resistance between 200 K and 2 megohms, and pick a value for C1 that gives the speed you want. C will depend on the supply voltage, among other things, but generally it will be in this range: C(in ufd)= words per minute/3 x R(in megohms).

The switch S1 across Q3 provides a continuous "key down" condition for tuning the transmitter, if you need it. I tune up with a string of dashes, and mentally correct the meter readings to account for the fact that the key is "up" one-fourth the time.

Adjusting the Magikey for proper character formation is a snap. You can use a scope or a voltmeter at the gate of Q3, or an ohmmeter across the relay contacts. Either method is better than trying to go by ear. The adjustments are straightforward when made in this order:

1. Connect the ohmmeter across the relay contacts, or a voltmeter to the gate of Q3. Off-set the meter's zero to read zero with "key up." Note the meter reading with "key down," S1 closed.
2. Set the keying speed control for near maximum speed so that the meter can not follow key closures.
3. Close the key to the dash position and adjust R3, Q1 gate voltage, to cause the meter to deflect to exactly 75% of the "key down" reading. On the ohmmeter this is 75% of full scale, since the contacts are closed three fourths of the time when making properly formed dashes.
4. Close the key to the dot position and adjust R2, Q1 cathode voltage, to cause the meter to deflect to exactly 50% of the "key down" reading. On the ohmmeter this is 50% of full scale, since the contacts are closed exactly half the time when making properly formed dots.

That's all there is to it. The dot/dash/space ratio holds for all keying speed settings.

The power demands of the Magikey are minimal, a nominal 18 volts at 1.3 ma. A pair of small 9 volt batteries like Eveready No. 216 will give about 300 hours of operating time if the keying transistor is powered from the transmitter. If you steal the power for the keyer from the transmitter, it can be anything from 12 volts to 24 volts. Regulation isn't extremely important, but character weight varies with supply voltage. So a zener diode regulator for Q1 and Q3 is a good idea, if you steal the power from an uncertain source.

Construction is not critical, and if you don't use the keying relay, the parts easily can fit on a 2" x 3" PC board. The small size makes it a natural for adding to the base of your key, or even building into a vest pocket CW transmitter. I expect it will take longer to get the "feel" of automatic dots and dashes than it will to build the Magikey. The Magikey has only a limited amount of magic in it, though. It can't transform a lid, but it sure can cure a banana-boat swing.

You can buy the drilled PC board, or kit, from the author.

. . . W3SGV

[1] "The Polar Key," K4YWS, *73 Magazine*, April, 1968.

Using the Paxitronix Frequency Divider with a Transceiver

The Paxitronix IC-3 Frequency Divider is a little gem which provides 25 kHz markers from your 100 kHz crystal calibrator. With the sub-division of our ham bands, a unit of this type is almost a necessity. However, I feel a word of caution is in order.

Installation of the IC-3 into a receiver is straightforward, and presents no problems. However, the application into a transceiver requires the obvious prevention of *rf* being fed back into the calibration unit; i.e. you just cannot hook the IC-3 output back to the antenna terminal (coax fitting) of the transceiver.

The Drake TR-4 circuit diagram shows a "gimmick" connection running from the plate of the crystal calibrator tube (V-5 Pin #5) to a lead to the grid of the receiving section *rf* tube (V-7). In actuality, they run this lead to a wafer switch and secure it so it couples into the circuit *without any physical electrical connection.* It is possible to hook right to pin #1 of V7 with the blue output lead of the IC-3, but this will require retuning the *rf* coils, and is both undesirable and unnecessary. I ran another gimmick wire to the same wafer switch on the Drake, and utilized one of the spare terminals to hold the blue lead mentioned above. The output is less than the 100 kHz crystal provides, but is more than adequate if the band is quiet or the antenna is disconnected during calibration. More output can be obtained by putting a 6 or 10 pF coupling condenser in series with the blue IC-3 output lead and hook onto pin #5 of the calibrator tube V5. This connection may be more easily made at a circuit board conveniently located in the TR-4. This now couples back, using the original gimmick arrangement and requires no TR-4 circuit changes.

Just to complete the picture, the red wire of IC-3 goes to pin #1 of V-20 (OA2), the yellow wire to pin #5 of V-5 (pick up on circuit board), the brown wire to the cathode resistor R29 on the circuit board. This connects pins 2 and 7 of V-5 so that switching the calibrator off and on, also switches the IC-3.

Equal credit for this idea should go to K4WM. His steady hands did the soldering.

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Ed. Note: A 10K, 2 watt resistor should be placed across R112 (2.5K, 7 W resistor) to compensate for the 10 ma drawn by the IC-3.

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FM = Fun Maker

Most amateurs have heard of FM operation on the vhf ham bands but few are actually aware of "what's happening" and why the trend towards FM vhf, especially why mobile FM. The purpose of this article is to give some insight into an exciting phase of amateur radio that seemingly has been overlooked by most. It is only within the past two years that this phase of amateur radio has grown so large that ignoring it would be cheating oneself of full use of his amateur privileges.

The majority of FM activity is taking place on six meters (called low-band) and two meters (called high-band). Activity can also be found in lesser amounts on the 10 and 3/4 meter bands. All operation is crystal controlled, both on receive and transmit. This eliminates receiver and transmitter tuning and missed calls. Receivers become more sensitive since they don't have to be broad-banded to cover the entire band. FM is noted for its quieting factor, which most say is better than AM. The audio level is constant regardless of how strong or weak the signal is. Two types of operation are generally in use. One is direct station-to-station (mobile to base, base to base, mobile to mobile, etc.). This direct communications is defined as simplex operation. The other is via a repeater function. The use of a repeater increases the average mobile coverage to 30 to 50 miles of solid, noiseless, communications. The repeater and its basic operation is explained later.

For those of us who must satisfy (justify may be a better choice of word) the XYL on the cost of a mobile installation and its appearance, your best bet is FM. Most of the equipment available today is "trunk mount." That is – the transmitter/receiver combination mounts in the trunk of the car and out of sight (point No. 1). All that mounts in the front of the car is a small control head (point No. 2). The speaker can be mounted up against the fire wall if necessary (point No. 3) so all that is showing in the entire mobile installation is the control head. The control head is so small one would never notice it unless it was brought to his attention. The antenna also is a wife pleaser in that two and six meter whips are smaller and less conspicuous than 20 or 40 meter whip antennas.

FM has considerable potential for emergency communications, since operation is simplified and the performance is of commercial quality. If the above does not prove a satisfactory argument for the XYL to allow a mobile installation, seriously consider the safety factor. If you or your wife are out in the car late at night and should the car break down all you have to do is pick up the mike and request help. Since everyone is crystal controlled on the same frequency you will be heard immediately. The larger (more populated) the city you're in, the more you need radio in the car for safety's sake. It also follows that the larger the city, the more FM radio amateurs there are. The need for safety in a large city and the response for help by FM you will receive if plotted graphically would display similar curves.

The FM mobile equipment is turned on with the flip of the ignition key and is ready to monitor without tuning. The mobile equipment is always on the correct frequency. Ninety-eight percent of all equipment in use today is modified commercial FM two way radios that have been taken out of service from Police, Fire, Taxi, etc. The brand names most popular are Motorola, General Electric, and RCA. Most equipment in use runs between 30 to 60 watts output. The amateur can find for sale (from another ham) a complete FM set-up which includes transmitter/receiver (almost always on one

chassis), control head, speaker, microphone, and all power and control cables. The price for all this is only between $50 and $150 depending usually upon the age of the unit in question. Tube sets using dynamotors usually go complete, all tuned up with proper crystals and the aforementioned accessories for around $50. A unit that is relatively new (manufactured in the last six years or so) that has a transistorized power supply complete with accessories would sell near the $100 range. There are units now on the market that run 80 watts output and are completely transistorized except for the final, complete with accessories that sell upwards of $350. But no matter what is finally purchased (or horse traded) an FM installation is generally much less in cost than most amateur SSB mobile gear. The price range is generally the same regardless of band chosen. The factor that varies the price of a given unit would be law of supply and demand and popularity of the unit in that given area. If units are purchased directly from a commercial outlet, conversion for ham use requires purchasing commercial grade crystals and retuning various stages. Two meter gear requires padding the front end of the receiver. UHF equipment (450 mhz) generally needs no modification except for obtaining new crystals and retuning. Additional output "sock" can be realized through the use of a gain antenna. Usually in regular amateur mobile service the vertical antenna gain at best is unity (1). On two meters and higher a gain of +3 db can be had by using an antenna of greater than 1/4 wave length. On two meters the 5/8 wave length antenna is popular. The effective output of the transmitter is doubled by use of the gain antenna.

Throughout the country 146.94 mhz and 52.525 mhz are found to be the most active frequencies. These frequencies have been designated National Emergency and Calling frequencies. National repeater frequencies are: six meters 52.80 mhz input, 52.72 output; and on two meters: 146.34 mhz input, 146.76 output. In some areas however, the repeater has output(s) on the main frequency (above).

Repeater stations have become quite popular recently and are now in operation throughout the country. These repeaters receive on one frequency (i. e. 146.34 mhz) and retransmit the received signal on another frequency (i. e. 146.76 mhz) simultaneously. This gives mobile stations the advantage of higher power and an extremely high antenna. Mobile-to-mobile operation is extended greatly. Right now it is possible to travel across the country working through a repeater in one area and working through another repeater as you approach the next area. This is why standard repeater frequencies are a must.

The Maryland FM Association in the Baltimore area has an active repeater on the two meter band. An in-band six meter repeater is scheduled for operation soon. The two meter repeater has an input of 146.34 mhz and retransmits out on 146.76 mhz. Due to my job I am in and out of the car all day long. I can't spend the time tuning in stations, loading up the rig, calling CQ and hoping someone will be listening on the frequency I choose. Since most of my travel is on the highway at 60 mph I'd rather pay attention to the road and traffic. With the FM installation I just pick up the microphone, hit the button and say, "K2PTS mobile listening." Since my signal goes through the repeater my mobile now has the extra sock of high power and an antenna at 200 feet, nine times out of ten I will get a reply.

The FM mode can not be compared to any other form of operation. Even so, FM still holds a place for every type of interest in the amateur field. For the vhf DX man the remote base stations and repeaters make ordinary ground-wave communications through use of these facilities comparable to the best band openings. On the technical side, the builder and experimenter will become engrossed in the complexities of long distance inter-connected repeaters, remote control, mobile telephone, etc. Those interested in net operation find that the FM mode fits in nicely with Civil Defense, RACES, MARS, AREC, etc. For the mobiler the advantages are infinite.

There is so much more to FM than just getting a signal report. The resemblance between FM and any other mode is purely coincidental. Why not give FM a try?

. . . K2PTS

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The SB100 on Six Meters

I am the proud owner of a Heathkit SB100. This rig has performed so well that I just had to invent something that could be wrong, et voila, I found it. It did not work on six meters.

Now, if you are willing to take in stride the loss of the 29.5 to 30 mhz band portion, reduced power output, just one band segment of 500 khz and reversed dial readings on the vfo and mode switch, I can tell you how to put this rig on six meters. Reports received show that it performs on six like a Heathkit should. But if you are a hammer and chisel man, do not try it.

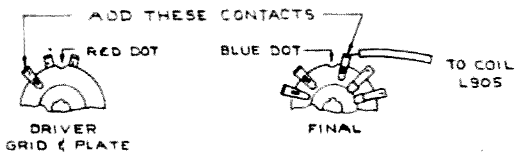

Fig. 1. Adding short switch contacts to the driver grid, driver plate, and final bandswitch.

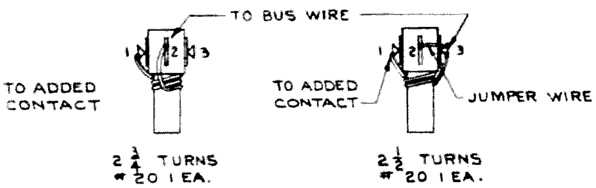

Fig. 2. Detail of the coils

The most delicate operation is to add one short switch contact to the driver grid, driver plate and final band switch. The slotted hole contacts of the driver switches are not too easy to handle. Try to find a wafer segment that is like the driver switch, break it apart, straighten the tabs that held the contacts with a pair of pliers and pull the tab out of the contact slot. Then assemble the tab to the driver band switches from the back. Fix the contact over it in front of the switch, and solder very carefully together. Be sure that no solder flows in between the contacts. The assembly of the final is done in similar fashion with a round eyelet contact.

The driver coils were made of some old 41 mhz transformers soldered directly to the added contacts for support. I used a No. 20 wire close wound.

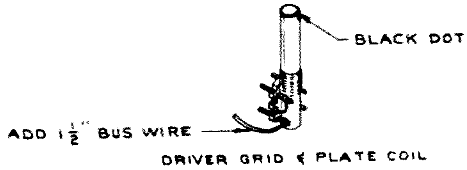

Fig. 3. Driver grid and plate coil with bus wire attached.

Tests have been made to use a 58.395 mhz heterodyne crystal, but this required changes in the heterodyne oscillator circuit, gave less output and was finally discarded. I settled for a low side 41.605 mhz crystal, and quickly got used to switching to LSB instead of USB and to reading the vfo dial backwards:

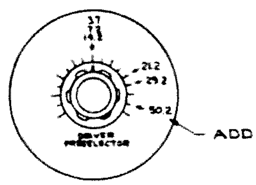

Fig. 4. Adjusting the driver preselector.

50.0 mhz=500
50.1 mhz=400
50.2 mhz=300
50.3 mhz=200
50.4 mhz=100
50.5 mhz= 0

Tune up is best done with an SWR meter. ALC and rf output readings are reduced on the SB 100 meter.

The modifications are as follows and are in the proper sequence:

1. Remove coil cover and support rail for better access.
2. Unsolder and remove 38.395 mhz crystal from heterodyne crystal board.
3. Replace with 41.605 mhz crystal (part No. 404-264 SB 110).
4. On heterodyne oscillator board, remove 2 turns from 29.5 mhz coil (blue dot) and resolder.
5. Add three short switch contacts to driver grid, driver plate and final band switch. See Fig. 1 and text.

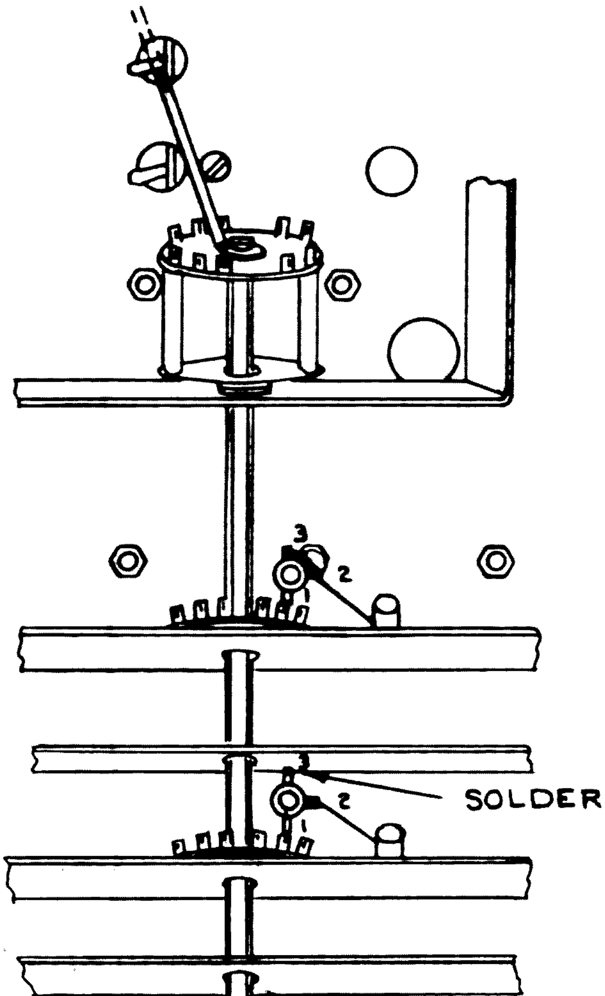

Fig. 5. Completed assembly of the band switch.

6. Tap 10 meter coil L905 in the middle with heavy red wire and run through hole DB2 in chassis to added short contact on final band switch. Solder each end.

7. Make 2 coils. See Fig. 2 and text.

8. Connect bus wire 1½ inch long to 29 mhz driver grid and driver plate coil form (left hand bottom, see Fig. 3) and solder.

9. Solder 2-3/4 turn coil to added contact on driver grid switch and added bus wire from 29 mhz driver coil (black dot).

10. Solder 2¼ turn coil to added contact on driver plate switch and added bus wire from 29 mhz driver plate coil (black dot).

11. Punch two holes for access to new coils into coil cover.

12. Reassemble support rail and coil cover.

13. Adjust heterodyne coil per manual.

14. Adjust driver preselector to Fig. 4.

15. Peak driver grid and driver plate for maximum per as manual.

. . .WB4CXL

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Measuring the Frequency of Unmarked Crystals

Surplus, unmarked crystals are easy to obtain, but are of little value to most experimenters since the frequencies are unknown. By using a Grid-Dip-Oscillator and/or a surplus frequency meter, the frequencies of the unmarked crystals may be determined to an accuracy exceeding 1% depending on which instrument is used.

Measurement with Grid-Dip-Oscillator

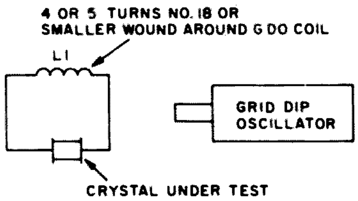

Fig. 1. Setup for rough frequency determination.

Fig. 1. shows the setup for using a Grid-Dip-Oscillator to roughly determine the resonant frequency of an unmarked crystal. L1 is a four or five-turn link, wound around the coil of the GDO. The coil may be soldered to a crystal socket or wrapped around the pins of the crystal being checked. To find the approximate frequency of the crystal, choose a low frequency band coil such as 2 to 5 mhz first, using the higher bands last. Avoid starting with high band coils as the measured frequency may be an overtone. Insert the coil in the GDO, place the GDO in the oscillator position, couple L1 tightly to the GDO coil and vary the frequency of the GDO from low to high very slowly. At resonance, the GDO will dip very sharply. It is important to vary the frequency slowly or the sharp dip will be missed. The dial of the GDO will now read the approximate frequency of the crystal. If a dip is not obtained, it will be necessary to use the next highest coil for the GDO. When resonance is obtained, it will be possible, with careful tuning, to maintain a steady dip, at which point the GDO will be locked to the frequency of the crystal. It is now possible to use a general coverage receiver to pick up the oscillating crystal and thus determine the frequency of the crystal to an accuracy better than that of the GDO. If a general coverage receiver is not available, a surplus frequency meter such as the BC 211, may be used.

Measurement with the BC 221

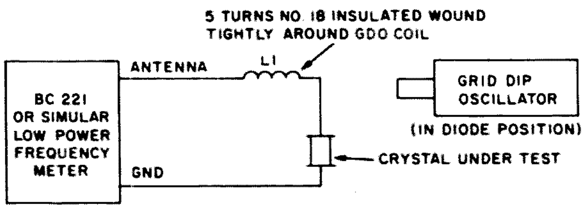

Fig. 2. Setup for accurate determination of crystal frequency.

Fig. 2 and **3** show two setups for using the BC 221 frequency meter to measure the frequency of unmarked crystals. **Fig. 2** uses the GDO as a detector, while **Fig. 3** shows a more sensitive arrangement using a VTVM as a detector.

With the BC 221 or similar frequency meter, the crystal is connected across the output terminals, and the detector either coupled through a loop in the circuit or directly across the crystal. If a GDO oscillator is a part

of the station equipment, the quickest way to determine the frequency is to first roughly find the frequency of the crystal using the GDO as previously described. After the rough frequency has been determined, place the crystal in one of the circuits as shown in Fig. 2 or 3. If the GDO is used as the detector, do not alter the tuning when placing the GDO in the circuit. Starting at a frequency known to be above or below the rough crystal frequency, very slowly vary the frequency of the BC 211 toward the rough frequency, until an indication is observed either on the GDO in the diode position or on the VTVM. The indication in either case will be an upward deflection on the meter. In the case of the VTVM as a detector, there should be some residual reading on the meter which will increase when the crystal frequency is reached. In some cases, depending on the

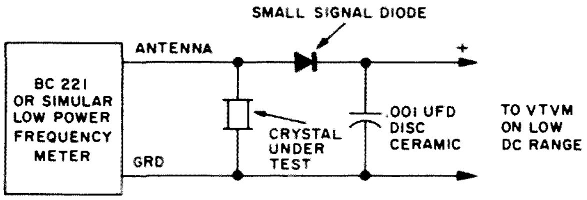

Fig. 3. Alternate setup for accurate determination of crystal frequency.

type of GDO and the frequency, the indication on the GDO may be barely discernible. In this case, it is recommended that the VTVM be used as the detector. If a GDO is not available, and it has been impossible to determine the rough frequency of the crystal, then the task is more time consuming. It will now be necessary to start the frequency meter at its lowest frequency and slowly vary the frequency upwards until an indication is noticed on the detector.

By using the techniques described, I have measured crystals in the range of 2 to 12 magacycles with the results exceeding 1% accuracy. If it's necessary to determine the frequency of a crystal to an accuracy much better than this, then the crystal should be placed in the oscillator to be used, and the frequency checked by using more sophisiticated methods. These techniques are presented because of their speed, simplicity, and reasonable accuracy.

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Getting Your Extra Class License

Part VII - Receivers

STAFF

Last month, we examined the nature of noise and also took a look at the various types of detectors used in communications receivers. In this installment of the Extra Class study course, let's stick with receivers a little longer and find out some of the more exotic details.

In doing so, we'll cover eight of the questions on the FCC study list—a few more than we usually take care of in a single section, but these are all rather closely related. The specific questions involved are:

11. How does a squelch circuit operate? Draw a commonly used squelch circuit.

33. How should a wave trap be connected to a receiving antenna circuit to attenuate an interfering signal?

45. How do receivers for remote control of objects and regular type communications receivers differ in basic operation?

46. How will a long and a short time constant AVC circuit affect reception?

51. How do trimmer and padding capacitors affect receiver tuning?

59. Define the conversion efficiency of a mixer tube.

68. What is the image-response of a receiver? How can it be reduced?

70. What effect will extending the low-frequency response to a signal have on the design of an SSB receiver?

As always, we won't attempt to answer any of these questions directly. If your only interest is in memorizing answers, there are other sources for that kind of information. Instead, we'll frame a set of more general questions which will cover all these and more besides, and in the process of finding the answers to that more general set, get the answers to the study questions and all related queries.

The major subject involved in all these questions is that of receiver design and operation. A logical starting point, then, would be to ask "What influences receiver design?"—but that's just a little *too* big a question for our space. At least one book of more than 1,400 pages has been written on that one, and the only way the subject was met in so little space was to make generous use of references to other volumes throughout!

So we will use a similar starting point, but a more restricted question: "How does the purpose of a receiver affect its design?", which will take care of question 45 among others; then we'll try to determine, "How do signal characteristics influence receiver design?" and this should cover questions 46 and 70.

Most of today's receivers are superhets, and superhets have some special problems. That's our third question—"What are some of the special problems of superhets?"—and it will equip us to answer questions 51, 59 and 68 on the FCC list. Regardless of receiver type, interference is always something which must be faced, and our final generalized question will be "How can we combat interference?" That should take care of questions 11 and 33 among others.

All set? Let's move out.

How does the purpose of a receiver affect its design? Radio receivers are designed for many purposes, and it appears obvious that the purpose of any individual receiver must affect its design rather strongly. The difference in design and performance between an inexpensive transistor pocket portable BC set and a top-grade SSB communications receiver is obvious—but each is adequate for its intended purpose, and neither has too much performance to meet that purpose.

The purposes to which receivers are put are so varied that we cannot list them all. Some of the more common are communications (that's our own use, mostly), entertainment (BC radio, FM, and TV), remote con-

trol (R/C models and garage-door openers, for instance), and measurement (a field-strength meter is, after all, merely a calibrated receiver).

The purpose of a receiver affects its design in many ways—but virtually all of the differences are in "performance parameters" such as selectivity, sensitivity, stability of tuning, distortion, and so forth. Regardless of the purpose to which the receiver is to be put, the absolute basics of the design and the principles upon which it operates remain pretty much the same for all receivers.

After all, *any* receiver must perform the functions of isolating a desired signal from the many infesting the spectrum, building that signal up to a usable level, and converting the modulation of the signal back into meaningful operation. This is just as true of the receiver in a garage-door opener as it is of the sophisticated communications receivers used in manned space shots for capsule-to-ground communication; at this functional level there's no difference at all in basic operation between one receiver and another regardless of the receiver's purpose.

However, some purposes require more precise performance in certain parameters than do others. For instance, a garage-door opener need not be capable of being tuned across the entire spectrum, or even across a wide band. It's going to be used with a single transmitter—or at least, a single group of transmitters all of which will be on the same frequency—so the tuning of its receiver need not be easily adjustable. On the other hand, a ham-band communications receiver must be able to be rapidly and accurately tuned to any frequency in any of a number of widely-separated amateur bands.

Similarly, a color-TV receiver must accept signals within a passband almost 6 mhz wide without significant distortion of any of them—but a communications receiver's passband, to be useful today, should not exceed 6 khz, which is three orders of magnitude smaller.

Differences of this sort, which are almost completely dictated by the purpose to which the receiver will be put, require completely different circuit designs to provide the required performance. Viewed at the circuit-operation level, then, the design is dictated completely by the purpose of the receiver, and each different purpose requires a different set of basic operating principles.

To illustrate, here are some of the key performance parameters for several different receiver purposes:

A communications receiver may be either "all-purpose" or "specialized;" a ham receiver would be "all-purpose" in that it must be able to receive many different types of signals from many different transmitters, while a police mobile receiver is "specialized" in that it need receive only one type of signal from one (or a very few) transmitter. Both, however, *are* used for communications.

An all-purpose communications receiver needs to be capable of easy tuning to any desired frequency, with excellent frequency stability once the desired frequency is reached. Selectivity of such a receiver should be adjustable, so that it may be set as narrow as possible for any one desired signal, and the selectivity should be sharp in order to pick one signal out from adjacent-channel interference. The sensitivity of the receiver should be maximum, so that it is not a limiting factor in performance. Distortion of the modulation should be small, but need not be reduced to the vanishing point. Audio power output need be only moderate. Finally, the receiver should be capable of receiving any type of modulation used for communications: AM, FM, SSB, CW, FSK, and so on.

A specialized communications receiver needs to meet essentially the same list of specifications, except for those requiring ease of adjustment of some factor which is absent in the specialized application. An example of such an exception is the fact that a police receiver need not be capable of receiving SSB, nor need it be tunable in most cases.

An entertainment receiver may be a BCB audio receiver, an FM audio receiver, or a TV receiver, and the parameters for each of these three are different.

A BCB audio receiver need cover only the limited frequency range of the broadcast band, with sensitivity adequate for reception of local stations. Cost should be minimized in the design and all unnecessary frills left out. Audio output should be moderate, and distortion reasonably low. Good AVC action is a necessity, and the selectivity should present a passband wide enough to permit reception of music. The number of adjustments should be reduced as far as possible; in most cases only two controls—tuning and volume—are provided.

An FM receiver requires excellent sensitivity, extremely low distortion, and sharp-sided selectivity over a relatively wide passband. Automatic frequency control is desirable since mistuning can create extreme distortion, and inclusion of multiplex stereo

capability is also desirable.

A TV receiver is actually two receivers in one; FM for audio and AM for video. It must be easily switched from channel to channel, but continuous tuning is not necessary. The passband must be very wide, and distortion must be even lower than that acceptable for FM audio if color signals are to be received (even in a monochrome receiver). Special detection and sync circuits are also required, as are the sweep circuits for presentation of the recovered video modulation.

Receivers used for remote control of objects need only moderate sensitivity, moderate selectivity, and produce on-off control signals rather than audio as their output. Designers could care less about distortion in simple remote-control units, although if multi-channel tone modulation is used the distortion may become a design factor again.

Finally, the performance parameters for a receiver to be used as a measuring instrument depend entirely upon the measurement to be made.

Now we can answer our original question: The purpose of a receiver has no effect upon the most basic functional operation of a receiver, which is that of receiving and demodulating a radio signal, but it has every effect upon the choice of particular circuits which may be used to perform that basic functional operation.

How do signal characteristics influence receiver design? We have just seen how the purpose to which a receiver is to be put makes the first determination of the types of circuits the designer may include in that receiver—and one of the major areas in which this de-determination is made is that which depends upon signal characteristics.

A CW signal, for instance, can be received easily with a receiver passband only 100 hz wide (if you can tune that closely, and stay on the signal). A TV signal, on the other hand, is nearly 5 mhz wide, and the receiver's passband must be at least as wide as the signal in order to get all the signal in.

Actually, selectivity is not the only design factor which is strongly influenced by the characteristics of the signal to be received. At least three other areas are as strongly affected: the type of demodulator or detector to be included depends entirely upon the modulation of the expected signal, the audio response (or lack of it) is determined largely by the signal, and the AVC attack and decay times are also tied rather closely to the expected incoming signal and the type of modulation on it.

In the selectivity region, the general rule is that the receiver should accept with a reasonably flat-topped passband a slot of spectrum space as wide as the signal, but no wider. If the bandwidth of expected signals varies, the receiver designer may take either of two courses: if the variance is large, and the user of the receiver can be expected to be a trained or experienced radio operator, the passband may be made adjustable. This is the route taken in ham-band receivers, for instance. If the variance is not so great, or if the receiver user cannot be expected to know how to manipulate many controls, then the passband may be fixed at a width great enough to accept the widest expected signal. This route is taken with FM entertainment receivers, for instance, where the bandwidth at any instant is determined by the modulating signal but the maximum bandwidth is known to the designer.

Fig. 1 lists the maximum bandwidth normally associated with the most common types of signals.

Type of signal	bandwidth (khz)
CW, 10 wpm	0.04
CW, 100 wpm	0.40
CW, x wpm	0.004x
AM communications	6
SSB communications	3
AM broadcast	10
FM broadcast	200
TV broadcast	6000
FSK, 425-Hz shift	1.25

Fig. 1. Bandwidth requirements for various types of signals. Bandwidth for any specific signal depends upon frequencies in modulating signal, which in turn depend upon amount of information being transmitted. High-speed cw requires more bandwidth than does low-speed transmission; voice requires more bandwidth than either.

The choices among detectors were covered in some detail in our previous installment, and we won't repeat that material. The type of detector included in any specific receiver design is rather obviously dictated by the type of signal expected, whatever type of circuit is chosen must be capable of demodulating the expected signal to give the type of output signal required by the purpose for which the receiver is to be used.

The frequency response of the amplifier or amplifiers which follow the detector stage is also influenced greatly by the type of sig-

nal expected. For example, a receiver intended to bring in CW only might go to the extreme of including narrow-band audio filters after the detector stage, to help achieve the extreme selectivity which may be needed in CW reception under poor conditions. The audio response of a top-quality entertainment FM receiver, on the other hand, must be wider in frequency range than the human ear, in order to be certain that the receiver in no way limits the quality of the reproduced signal.

For remote-control receivers, if a simple on-off type of control technique is to be used, the amplifiers after the detector need only be capable of triggering a dc signal on or off to achieve the necessary control. Receivers intended to produce audio output, on the other hand, need not have any low-frequency response below 15 to 20 hz since the ear cannot hear signals of lower frequency, nor can most loudspeakers reproduce them.

For communications use, the audio frequency range of the receiver is normally limited to the speech region, from 300 to 3000 hz; elimination of the higher frequencies helps reduce annoyance and operator fatigue from the high-frequency components of hiss, and reduction of the lower frequencies restores a balance to the signal which would otherwise sound "tubby" or "mushy" and be difficult to understand.

If the low-frequency response of a receiver intended to be used with SSB signals is extended to match that of an entertainment receiver, performance may actually be degraded with the SSB signals. This occurs because the locally-supplied carrier used to demodulate the SSB signal rarely is a perfect match in frequency for the suppressed original carrier, and almost never is a match in phase.

Any slight frequency error between original and reinserted carrier frequencies is an absolute rather than relative error, and is usually less than 50 hz (more than 50 hz error renders the signal unnatural in any circumstances). Its effects, however, are relative, because the original effect of the error is to move *all* the speech frequencies within the signal away from their proper positions by the amount of the error but in the opposite direction. That is, if the local carrier is 40 hz too high in frequency, each frequency in the reproduced signal will be 40 hz lower than it should be. (This is true only if the *upper* sideband is being received at the detector input; if the lower sideband reaches the detec-

tor, the error will be in the same direction and each frequency will be 40 hz too high.)

The difference between a 2000-hz component of speech and a 1960-hz component is so small as to pass unnoticed, and the difference between a 350-hz component and a 310-hz component isn't particularly objectionable.

But the difference between an 80-hz component and a 40-hz component amounts to a full octave of pitch, and this is considered objectionable by almost everyone. Similarly, for an original component of 120-hz frequency the error would pull it down to 80-hz, which is like the shift from the note of C to the next lower G on the musical scale, and that too isn't very good.

Thus the effects of any frequency error between original and reinserted carrier are most objectionable at the low end of the frequency range. Preventing the audio stages after the detector from amplifying the low frequencies prevents these effects from being objectionable to the operator.

If for some reason a designer felt it necessary to include extended low-frequency response, he would then be faced with the necessity of providing extreme frequency stability and a means for achieving near-perfect tuning accuracy. Since the low tones contribute almost nothing to intelligibility of the signal, communications receivers simply operate with reduced audio response at the low end and thereby simplify these design problems.

Characteristics of the anticipated signals affect design of the AVC circuitry in a number of ways. The most extreme effect is that of determining whether AVC will be included in the receiver, or left out. For some types of signals, AVC need not be included, but in most cases it is anyhow since it adds little to the cost or complexity of the receiver and is frequently an operating advantage.

If AVC is to be included, the manner in which its control voltage is generated is determined by the signal to some degree. For instance, the FM discriminator does not provide an AVC control voltage; if such a detector is used a limiter stage must be included, and the AVC control voltage may be taken from this limiter stage where it is generated as a by-product of limiting action. The FM ratio detector, on the other hand, provides an AVC source as well as performing the demodulation of the signal. The envelope detectors used for AM detection usually provide the AVC voltage as well, but when SSB or CW signals are being received, the AVC must be developed separately from the detection process.

The function of the AVC circuit is to change the receiver gain in accordance with the signal strength; this prevents receiver overload as well as increasing the convenience of operation. Operation of an S-meter is not, contrary to some beliefs, the primary purpose of this circuit.

When the gain is varied, especially in the case of envelope detection of AM, the modulation may be affected. For instance, if a signal modulated with only a 100-hz sine wave were being received, and the AVC were allowed to change receiver gain rapidly enough to follow the 100-hz variation in envelope level, the modulation would be effectively wiped off the signal!

To keep such events from occurring, the time constants in the AVC circuit must be kept long enough so that receiver gain cannot change during a single cycle of any expected modulating signal.

If the lowest frequency to be received is 300 hz, the AVC time constants must not permit the receiver gain to change more rapidly than 1/300 second. Because the gain change is logrithmic with respect to voltage rather than being linear, and because time constants bear only a relative relation to voltage levels, the time constants are usually kept longer than 1/60 second. For communications use, a time-constant figure of 0.02 might be considered typical.

This is entirely too short a time constant for entertainment reception, where frequencies as low as 20 hz may need to be reproduced. The time constants employed in these cases are closer to 1 second.

The effect upon frequency response is not the only factor involved in choice of AVC time constant, however. One of the primary reasons for putting in the AVC in the first place is to combat fading of the signal, and fading may occur at a rapid rate. The fade of an aurora-reflected signal, for instance, occurs at a frequency well up in the audio range, and gives such a signal its characteristic buzz-saw whine.

And the time constants of the AVC circuit also determine how rapidly the receiver will be able to respond to a fade by increasing or decreasing gain. If the time constant is too long, a given signal will appear to be fading or fluctuating in level much more violently than if the time constant is short.

The choice of AVC time constant, then,

always represents a compromise between the long time constant needed for extended low-frequency audio response, and the short time constant necessary to permit rapid response to fluctuations in signal level.

So far our discussion of AVC time constants has been based on normal practice with AM and FM signals. When a designer includes AVC in a receiver intended to handle CW and SSB signals, additional factors come into the picture—but all the previous factors are still present too.

Any CW or SSB signal is always in a state of rapid fluctuation; you might call it a "deep fading" signal even if the transmitter is just down the block. The reason is that the signal level is tied directly to the modulation; with the key up, or the voice silent, there's no signal at all, and with the key down or on voice peaks, there's full signal.

When reception of such a signal is attempted, using conventional AVC design, the necessarily slow time constant keeps the receiver gain wide open in the absence of incoming signal—and holds it wide open for the first few fractions of a second after the signal arrives. During this time, the entire receiver is usually overloaded.

Eventually, the AVC time constants permit gain to be reduced, but by this time the signal is gone again. Gain remains low, now, until the time constants permit receiver gain to vary.

The net result is that the receiver is almost always overloaded, except when it's desensitized and cannot receive a weak signal!

To get away from this problem, the designer uses steering diodes to separate the AVC circuit's action into two distinct phases called "attack" and "decay." The attack phase is the gain change when a signal increases in strength, and the decay phase is the change when the signal decreases. By separating these two phases, different time constants may be employed in each. A fast time constant may be used for attack, and a slow—extremely slow, in fact—one for decay. The receiver then responds to an increase in signal strength almost instantly, and so cannot overload so easily. Once gain is reduced, it takes much longer for it to increase again. This permits the AVC voltage to reach and hold an "average" value during reception of CW or SSB signals.

The slow decay does handicap the receiver's response to a fading signal, and for this reason the fast-attack slow-decay design is usually used only when the CW-SSB detection

circuits are in use. If conventional AM is being received, conventional AVC is usually used with it.

The manner in which the AVC action is separated into attack and decay phases is illustrated in the schematic, **Fig. 2.** This is a

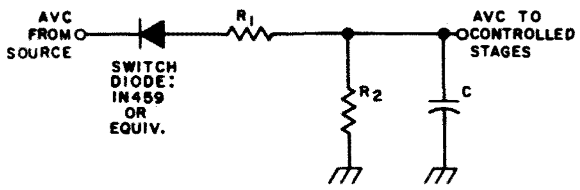

Fig. 2. Fast attack, slow decay avc circuits usually resemble this schematic, at least in basic operating principles. Diode permits capacitor C to charge rapidly, but limits discharge path to r2 alone. R2 has very high value so that time constant c-r2 is long, while attack time constant c-r1 is short. See text for details.

typical application rather than depicting any individual design. The AVC control voltage varies from zero to some maximum negative value, usually not exceeding 25 to 30 volts in absolute magnitude. Let's assume first that no signal is being received, and consequently the AVC line is at 0 volts.

Under these conditions the capacitor is discharged and the controlled stages operate at maximum gain. If a CW signal developing an AVC potential of -20 volts should suddenly arrive at the AVC generator, the voltage at point A would also go rapidly to -20 volts. This provides a 20-volt forward bias for the diode, and the capacitor charges at once through R1. This is the "attack" phase of the action, and the time constant for attack in this circuit is simply R1 times C.

When the "dit" or "dah" of the CW signal is over, the voltage at point A returns to zero, but now the capacitor is charged to somewhere near -20 volts. This is reverse bias to the diode, and so it looks like an open circuit. The only route available for discharge of the capacitor is by way of R2, which normally has a very high value (from 10 to 22 megohms, compared to ½ megohm or less for R1) and so provides a much longer time constant. This is the "decay" phase, and so long as the capacitor remains charged the receiver gain is reduced. Of course, C is discharging through R2 at all times and so the gain is slowly increasing from the moment the signal disappeared, but the time constant is so much longer than that of the attack phase that gain appears to be "constant."

If another signal appears to provide a -20 volts at point A before the capacitor has discharged appreciably, there will still be forward bias on the diode because the capacitor voltage is always less than 20 volts. This restores the "attack" phase and the capacitor recharges.

So long as signal appears before the decay time constant has expired, then, a relatively constant voltage of almost the full potential value appears on the AVC line. The receiver's gain remains low between dits or dahs, and between syllables of an SSB signal.

While the decay time constant is long, in comparison to the attack time constant or even in comparison to communications-oriented conventional AVC time constants, it is short enough to permit full gain to be restored between words of a CW or SSB transmission. This permits round-table discussions between stations of vastly different signal strengths—and can occur only because the attack time constant is short enough to prevent overload for any incoming signal.

What are some of the special problems of superhets? The most widely used type of receiver today is the superhet, which combines a number of features from older designs to achieve almost any combination of sensitivity, selectivity, and stability which anyone is willing to pay for. These advantages, though, have a price in that superhets have a number of special problems which do not occur with the older, simpler types of receivers. Our question now is, what are some of these special problems?

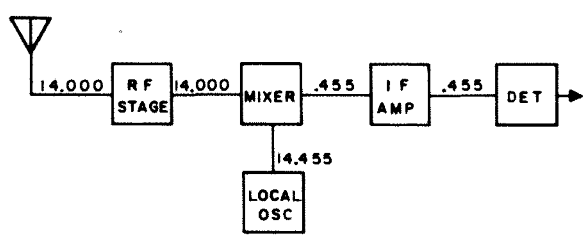

Fig. 3. Block diagram of typical superhet receiver front end shows basic operating principle of superhet design. Incoming signal, in this case at frequency of 14,000 mhz, is amplified and then applied to a mixer stage where it is mixed with a local oscillator signal at a different frequency, here 14,455 mhz. One of the resulting modulation frequencies, here 455 khz, is selected as the "intermediate" frequency and all remaining amplification is applied to it. Detector then converts intermediate frequency to desired output.

The superhet operates, as shown in **Fig. 3,** on the principle of mixing two signals to produce a third signal at the "difference" frequency which contains the modulation of both original signals. By making one of the

two signals come from the antenna while the other comes from a local, variable-frequency, unmodulated oscillator, the resulting difference frequency will have the modulation of the antenna signal only. If the locally supplied signal is offset from the antenna signal by a fixed frequency, the difference frequency will be numerically equal to that offset. That's the secret of the superhet's success: it has permitted *rf* amplification to be done at a single, fixed, "intermediate" frequency so that the desired sensitivity and selectivity can be obtained, while permitting reception of antenna signals at almost any frequency.

The first special problem peculiar to superhets is that of the mixer stage itself; this stage is absent in all other types of receivers.

The next major problem of the superhet is that of local radiation; the local oscillator signal may, unless designers prevent it from so doing, couple its signal back into the antenna and then the receiver doubles as a low-powered transmitter. Mutual interference between superhet receivers is not uncommon —for a number of years the Navy avoided the superhet for shipboard use because too many receivers of this type operating so close together as they must on board ship blocked each other out. However, careful design can solve the problem, and a little later we'll see how it's done.

The third major problem on our list is that of "image response;" it comes about because for any single frequency to which the local oscillator may be tuned, *two* antenna signals may exist to produce the intermediate frequency. For example, if you want to receive a signal at 7250 khz and your *if* is 500 khz, you can tune your local oscillator to 6750 khz (500 khz lower than the desired signal frequency), and the *if* amplifier will accept the resulting 7250-6750=500 khz output. But, it will also accept the 6750-6250= 500 khz output which would be produced by a signal at 6250 khz, and that undesired response is known as the "image."

Like re-radiation, it can be cured by careful design and we will look at this one too in more detail.

The final problem we'll examine is that of "tracking;" the superhet receiver requires that a local oscillator's frequency be varied to tune in any signal, and normally both the mixer stage and an *rf* amplifier are also tuned—but to the frequency of the signal, rather than that of the local oscillator. Since the two frequencies are offset one from the other, it takes some involved juggling of resonance

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formulae in order to achieve this "tracking" as the receiver is tuned across any appreciable frequency range.

Let's take these four problems and look at them, in order, a little more closely. We'll start with the mixer stage.

The purpose of the mixer stage is to produce modulation or sum-and-difference frequencies which are the sum and difference of the incoming *rf* signal and the local oscillator signal. One of these modulation frequencies —usually the difference frequency—is selected as the intermediate frequency for amplification and subsequent detection.

If the local oscillator and the mixer stage are combined in a single tube, that stage is usually called a "converter;" if they are separated into separate sections, the terms "local oscillator" or "first oscillator" and "mixer" are used.

To quote the "Electronic Designers' Handbook," intermodulation between two signals can occur only in a nonlinear element; therefore, mixers and converters are necessarily nonlinear devices.

In theory at least, and to some degree in practice, almost any nonlinear device can mix signals, and thus can be used as a mixer in a superhet. At uhf, the most commonly used mixer is an ordinary diode. But at more conventional frequencies, most designers prefer to get more action than mere mixing out of the mixer stage. They like to make it produce some signal gain, some selectivity, and help to isolate the oscillator signal from the antenna, if possible.

For this reason, most mixers employ active devices—either vacuum tubes or transistors. These can amplify the signals, and the proper type of tube or circuit, or both together in most cases, can assist in isolating the various signals properly.

A number of different types of mixer circuit exist, as do several special types of tubes designed for mixing. Some of these special types include the pentagrid converter typified by type 6SA7 and 6BE6, the triode-hexode converter (virtually obsolete today), and the heptode and octode designs.

All, however, achieve their mixing in essentially the same manner: for one of the two signals to be mixed, the stage acts essentially as an amplifier. The gain of an amplifier is determined by the transconductance of the active device in it; in the mixer, this transconductance is varied by the second of the signals to be mixed.

The result is an amplifier whose gain varies at a rate determined by one *rf* signal, while it is amplifying another signal. Both original signals will appear in the output, and since the change in gain is anything but linear (see **Fig. 4**) the two signals intermodulate each other to produce side frequencies which are the sum and difference.

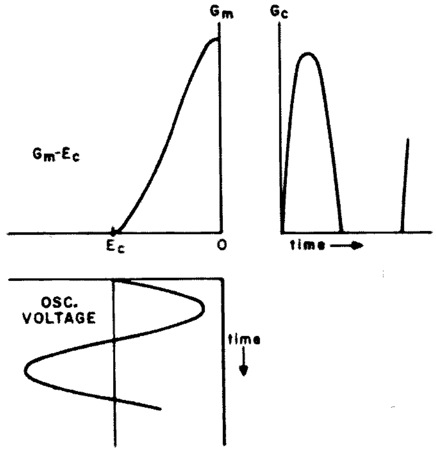

Fig. 4. This composite graph which relates tube transconductance to instantaneous grid voltage (upper left portion), oscillator voltage applied at grid to time (lower left), and resulting conversion transconductance to time (upper right) shows where the nonlinearity necessary to provide mixer action comes from. Oscillator voltage swings grid past cutoff at times, and conversion transconductance drops to zero during those times; even when tube is conducting, conversion transconductance is in constant state of change, and change does not follow a linear rule.

The output circuit of this "amplifier" is tuned to the desired output frequency, which is usually the difference frequency. Thus, both of the original frequencies as well as the sum frequency are by-passed to ground, while the desired output frequency is amplified.

The fundamental property of a mixer tube—or any tube used as a mixer—so far as the engineers are concerned is its "conversion transconductance," which is defined as the ratio of the peak output *current* at *intermediate* frequency to the peak input *voltage* at *signal* frequency. This value depends upon oscillator injection levels as well as upon the tube's inherent characteristics, so it must be measured under carefully controlled conditions. The difference between conversion transconductance and the more familiar plain "transconductance" of the tube is that conversion transconductance relates an output at one frequency to an input at another, while ordinary transconductance simply relates output current to input voltage, with both being at the same frequency.

The term "conversion efficiency" is apparently unknown to professional receiver designers. At any rate, it is not mentioned in "Electronic Designers' Handbook," the "Radiotron Designer's Handbook," Terman's "Electronic and Radio Engineering," or Bill Orr's "Radio Handbook." The only publication we could find which *does* mention this phrase, in fact, is the ARRL Handbook! The professionals in the field call this factor "mixer amplification" rather than "conversion efficiency"—but whatever the name used, it's the ratio of intermediate-frequency output voltage to signal-frequency input voltage, and you can calculate it by multiplying the *if* load impedance in the mixer plate circuit by the conversion transconductance of the stage.

Aside from achievement of adequate stage gain—or "conversion efficiency"—the major problem presented by the mixer stage is that of adequately isolating the local oscillator and the input signal each from the other, while providing enough injection to permit proper mixing action. If isolation is insufficient, the oscillator may be "pulled" by strong signals with a resulting frequency shift. In addition, the oscillator signal may be radiated to cause interference to other receivers, and performance will suffer due to circuit loading in the mixer and preceding stages.

Use of separate mixer and oscillator stages helps in control of signal isolation, as does the use of specially designed mixer tubes which minimize interaction between their two input circuits. When conventional tubes are found desirable, special circuitry may be used. See the previous installment of this study course for one such circuit which uses a pair of triodes to provide almost complete isolation of oscillator and signal frequencies while achieving good mixing action over a wide range of signal strengths and providing exceptional stage gain. For additional mixer circuits, refer to any of the books listed at the end of this installment.

The second problem we'll examine is that of preventing radiation from the local oscillator. This is tied up to some degree with the mixer circuit, but is not confined to the mixer alone. Several other factors must also be considered.

For instance, the re-radiation problem is always more severe when the mixer is connected directly to the antenna than when an *rf* amplifier comes between antenna and mixer. The oscillator signal is always present, to some degree, in the mixer's grid circuit even when the most isolating mixer possible is

used. If this grid circuit is coupled directly to an antenna, that small oscillator signal may escape. With the better mixer designs the amount of oscillator signal which can escape through the grid circuit is small enough to be within legal limits—but an intervening *rf* amplifier can reduce it still more, and will.

No number of intervening stages can prevent radiation, however, unless the local oscillator signal is rigidly confined within the receiver to the areas where it is necessary. This means that the oscillator circuit should be shielded as completely as possible, and that all leads to and from this circuit be either shielded or filtered, to make certain that no signal escapes to be coupled accidentally to any part of the antenna or power-line.

Re-radiation of the local oscillator signal can have serious consequences. Not long ago, radiation from garage-door openers was found to be interfering with the radio navigation equipment on jetliners in the crowded Los Angeles airport area. Fortunately no accidents resulted—but it was strictly a matter of good luck, because on at least one occasion the airliner was coming through overcast skies on a dead aim for the offending garage door when the pilot recognized that something had gone seriously wrong!

Because the consequences can be so serious, the FCC has set limits on the amount of radiation permissible from any electronic devices. These limits compose Part 15 of the Commission's Rules and Regulations—and the "Part 15" license-free transceiver units are legal to operate precisely because they come just inside the limit of permissible radiation. Only a small minority of the users of electronic equipment are aware of the existence of this part of the FCC regulations—but, the Commission holds the *user* of the offending equipment liable for any violation. Any receiver with more radiated signal than Part 15 allows is considered by the commission to be not a receiver, but an unlicensed transmitter! For this reason alone, radiation is one of the most serious problems faced by the designer of a superhet receiver.

The special superhet problem most obvious to the user of the receiver is that of images. As we saw a few paragraphs back, the image response comes about because *two* signal frequencies, rather than one, are capable of producing the proper intermediate frequency, and the receiver cannot tell the difference by the time the signal gets to the mixer output circuit.

Response to images can be minimized in only one way—by providing adequate selectivity *ahead* of the mixer stage. In some cases, this means that as many as two *rf*-amplifier stages may be necessary, but in others the mixer-stage input circuit may provide adequate selectivity by itself. It all depends upon the ratio between signal frequency and local oscillator frequency.

For example, an ordinary 5-tube clock-radio operating on the AM broadcast band covers a frequency range from 550 to 1600 khz, and normally has an *if* of 455 khz. The local oscillator could be operated either above or below the signal frequency, but if it were below its tuning range would have to be from 95 to 1145 khz which is greater than a 10-to-1 ratio from high to low frequency.

By using "high-side injection," the oscillator need only cover the range from 1005 to 2055 khz, or a little more than a 2-to-1 ratio from high to low, and so high-side injection is the universal choice.

When the receiver is tuned to 600 khz, the oscillator is then tuned to 1055 khz, and the image response point is 455 khz higher or 1510 khz. When the receiver is tuned to 700 khz, the image response is 910 khz higher or 1610 khz; this frequency is outside the broadcast band and very few signals can be expected there.

The result is that images can only be objectionable from the low end of the dial up to 690 khz, and the FCC helps keep even these down by setting up frequency assignments so that any area in which the local stations operate below 690 khz has few, if any, stations operating 910 khz higher.

Even when an image can be encountered with this simple receiver, it takes a strong signal to get through the 3-to-1 mistuning which exists at the mixer input circuit.

At the higher frequencies we use, though, the situation is rather different. The distance between desired signal and the image is still just twice the *if*, or 910 khz if the standard *if* is used—but this is such a small percentage of the signal frequency that both the desired signal and any possible image roll right on thru a single tuned circuit.

Sometimes, even the additional selectivity offered by one or two *rf* amplifier stages isn't enough. In such cases, a preselector may be used to reduce image response still more. The preselector is nothing but an additional, outboard *rf* amplifier—but it adds a few more tuned circuits to the signal path between antenna and mixer, and in addition it may if necessary be deliberately mistuned to one

side of the desired signal in order to cut down the image's strength still more.

A better answer than the use of the preselector is to use an additional mixer stage so that the first intermediate frequency is a much larger fraction of the signal frequency. The image response of such a setup is then removed much farther from the desired signal, and the preselector's action is much more effective. The resulting rather high *if* produced by the additional mixer stage is then converted again down to a low *if* for gain and selectivity. A process such as this is known as multiple conversion; if two intermediate frequencies are employed, it's called double conversion, and if three are used (as often happens, especially in uhf and vhf operation) it's triple conversion. The added stages may be outboard to the main receiver; in this case the whole outboard unit is known as a converter. Use of a converter is the standard technique for vhf operators, and finds much favor with hf operators who specialize in the higher-frequency bands where image responses are most troublesome.

Fig. 5 shows, graphically, the causes and cures of the image problem.

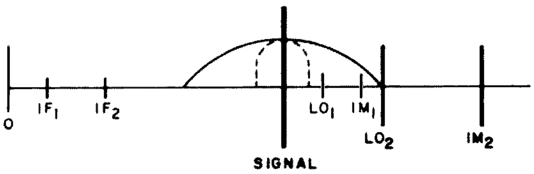

Fig. 5. Causes and cures of image problem are shown here. Heavy vertical line represents desired incoming-signal frequency and solid curve represents typical receiver front-end selectivity at this frequency. If if is low in comparison to signal frequency, as is the case with if1, then oscillator offset is small also (lo1) and the image response (im1) is still acceptable to front-end selectivity curve. Image response will be poor; images will come through almost as well as desired signals. Changing to higher if, as for instance if2, pushed oscillator offset out to lo2 and moves image point well outside front-end acceptance range to im2. If signal is sufficiently strong it can still get through, but image response characteristics will be much improved since only strong images can make it now. Alternate action to cure problem is to increase selectivity of front end as shown by dotted curve; this is usually done by using preselector accessory.

The final special problem of the superhet which we're going to look at this time is that of tracking. The object of tracking a receiver is to be able to simultaneously set to some desired frequency each of several tuned circuits, all of which are mechanically connected to each other and operated by a single control.

What complicates the situation in the superhet is the fact that the desired frequency for the oscillator's tuned circuits is different from the desired frequency for the signal tuned circuits, by the amount of the *if.*

In broadcast receivers, the tracking problem is simplified greatly by specialized mechanical design of the tuning capacitors. The plates of the oscillator tuning capacitor are shaped differently than those of the mixer and *rf*-stage (if any) capacitors, so that at any one position of the tuning control, the different circuits are automatically tuned to the appropriate frequencies.

In receivers which must cover more than a single frequency band, however, such a simple solution cannot be used, because the required shape to produce the necessary constant frequency difference differs from band to band. In these cases, tracking must be achieved by electrical means.

It's relatively simple to make the difference between signal and oscillator frequencies equal to the *if* at any two points within the tuning range, by proper choice of L-C factors in the different tuned circuits involved. The problem is not so simple when you want to make the difference at all points within the range equal; in fact, it's incapable of solution for *all* points in the range. The best the designers can do is to make tracking coincide properly at *three* points within the range. One of these three points is near the low end, another near the high end, and the third somewhere in between.

When three-point tracking is achieved, the oscillator will be lower in frequency than it should theoretically be at all points between the low-end tracking point and the mid-band point, and will be too high in frequency between the mid-band point and the high-end point. However, the error seldom exceeds a few khz—and in a superhet it's the oscillator frequency which takes charge, so the operator never becomes aware that any error exists.

To see how tracking is achieved, let's look first at single-point tracking. This is the kind of situation which exists in a fixed-frequency receiver—and of course if the frequency is never going to vary the term "tracking" isn't really applicable, but single-point tracking gives us a place to get started into the problems.

Fig. 6 shows schematically portions of the *rf,* mixer, and oscillator circuits which are involved with tracking. We'll assume that the three tuning capacitors C_{t1}, C_{t2}, and

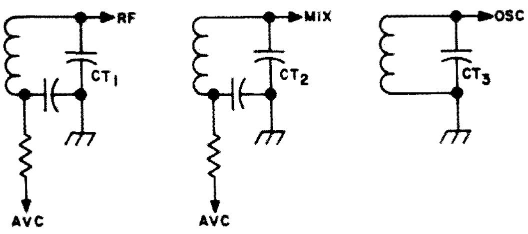

Fig. 6. Starting point for look at tracking problem is "signal-point" tracking such as for fixed-frequency receiver. Shown here are, left to right, rf-stage, mixer, and oscillator tuned circuits. With all tuning capacitors having same value, circuit can easily be adjusted to desired frequencies by varying inductance of coils. Single-point tracking has no problem.

C_{t3} all have the same value. In a single-frequency receiver this is not necessarily the usual case, and in fact is seldom the practice —but in a tunable receiver using multiple-ganged capacitors all three or more variables in the gang will have the same value at any position of the shaft, so this serves as our introduction to tracking.

To get the proper tracking condition at a single point, all we need do is to adjust the inductance values so that the three tuned circuits each tune to the proper frequency. If the oscillator operates above signal frequency, the oscillator coil will be set for a lower inductance than either the *rf* or mixer coils. When each coil tunes to its proper frequency, we have achieved single-point tracking.

Now let's see what happens when we try to achieve two-point tracking. This can be thought of as the design of a two-frequency receiver to receive either of two fixed frequencies. We can no longer adjust the coils individually for both of the frequencies, although we still have the option of adjusting coils for either one of the two. We must get our tracking at the other frequency by some other means.

To make our illustration as close as possible to the real tracking problem we're working toward, we'll modify the circuits of Fig. 6 so that they look like Fig. 7. The 3PST switch cuts in additional capacitance across the three tuning capacitors to select the lower frequency, and cuts it out to switch to the upper frequency. Again, all capacitances are identical, and the extra capacitances are also matched because what we're really modelling is a 3-gang variable capacitor. However, we now have added also a "trimmer" capacitor across the oscillator circuit. This trimmer is always in the circuit, at either frequency,

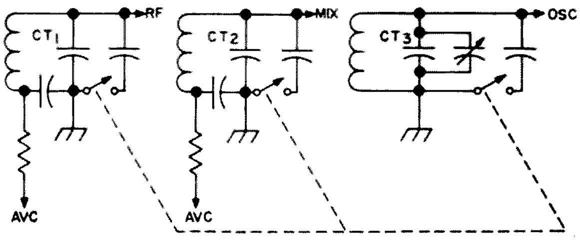

Fig. 7. Circuit of Fig. 6 is modified to require two-point tracking by addition of switch to permit choice of either of two frequencies. Trimmer capacitor across oscillator-circuit tuning capacitor makes it possible to find combination of capacitance and inductance values so that perfect tracking occurs at either frequency. At this point we can replace fixed running capacitors ct1, ct2, and ct3 with variable ganged capacitor shaft, to move from low to high capacitance. At any settings other than the two at which initial adjustment was made, tracking errors will exist. Over small tuning range though, error is not serious.

and it may be adjusted when we align the unit just as may be the three coils.

With the addition of the trimmer capacitor, we have made ourselves able to achieve two-point tracking. First we switch in the extra capacitance to tune to the lower frequency, and we adjust the coils for perfect tracking just as we did in the single-point case.

Then, though, we switch out the extra capacitors to tune to the higher frequency. With the extra capacitance out of the circuit, the trimmer represents a much larger proportion of the total capacitance in the oscillator circuit, and it's not in the signal circuits. We now adjust only the trimmer to pull the oscillator to the proper frequency. This assumes, of course, that the signal circuits arc already at proper frequency; that's taken care of in our choice of capacitor values originally. In practice, all three tuning capacitors have "trimmer" adjustments on them which are used to get the proper frequency setting for each individual circuit. This permits adjustment to compensate for stray capacitance and such things.

Since we readjusted the amount of capacitance in the oscillator circuit to get our high-end tracking, we cannot be at the proper adjustment at the low end any more. To correct this, we switch back to the low frequency and readjust the oscillator coil to correct the frequency. This adjustment pulls the high end off, but not so much as it originally was. We must go round in circles, adjusting first the low end, then the high, then the low again, until we finally reduce the error to zero at both tracking points. This occurs reasonably

rapidly, and we have achieved two-point tracking.

We can now replace the fixed capacitors and tuning switch, if we like, with a 3-gang variable capacitor. We have two-point tracking, which means that everything is all right at our two tracking frequencies but that some error exists at all other frequencies.

If our tuning is to be only over a narrow range with respect to frequency, such as the 7% difference between band limits of the 10-meter band, two-point tracking will suffice. The error will never be large enough to warrant any attempt to eliminate it.

But if a fairly wide frequency range is to be covered, such as the 2-to-1 ratio from limit to limit of the broadcast band, the tracking error will be excessive near the middle of the band, and we must go all the way to three-point tracking.

Three-point tracking is achieved by connecting a "padder" capacitor in series with the oscillator tuning capacitor. In most cases, additional capacitance must also be connected in parallel with the coil to restore total circuit capacitance. **Fig. 8** shows the mixer and oscillator tuned circuits only, including all components ever required for 3-point tracking. In some cases one or more of the components may be omitted; in such cases series capacitors are replaced by short circuits, and parallel capacitors are simply removed.

The oscillator's effective tuning capacitance, in **Fig. 8**, is the total produced by Cl in parallel with the series combination of C_p and the parallel Ct/Ctrim pair, as enclosed by the dotted line. This total effective capacitance tunes the coil to proper frequency.

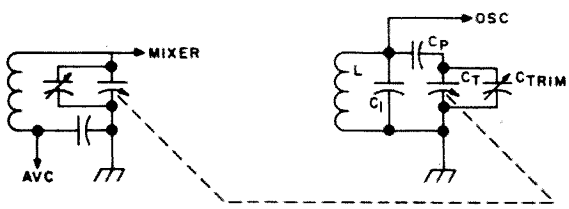

Fig. 8. Final modification of circuit to reach three-point tracking conditions involves addition of two more capacitors to oscillator circuit. One, Cl, serves purpose similar to that of trimmer in Fig. 7 and established minimum capacitance present in the circuit. The other, cp, is the "padding" capacitor and established both the maximum value of capacitance possible, and the way in which capacitance changes as tuning capacitor ct is rotated through its tuning range. See text for details.

When capacitor Ct is varied to tune to a different frequency, it varies the total effective capacitance—but the amount of variation is much less than it would be without Cl and Cp. Even if all other capacitors were completely removed, Cl would set a minimum value of capacitance in the circuit. Even if Ct were to be replaced by a dead short, Cp would set a maximum value on the effective capacitance. The only thing Ct can do to the total effective capacitance value, then, is to change it within the range established by Cl at the low-value end and Cl/Cp together at the maximum end.

Choice of the exact values to be used for Cl and Cp is the difficult part of the three-point tracking problem, and we won't go into that here; if you're interested in designing a receiver, see pages 1002 through 1017 of *Radiotron Designers Handbook* for a complete discussion including worked examples and seven graphs to assist in the choices.

When the values are properly chosen, however, the low-end tracking frequency is controlled primarily by Cl together with the maximum value of the Cp/Ct/Ctrim combination, the high-end frequency is controlled primarily by Ctrim together with the modifications introduced by the rest of the capacitors, and the mid-point frequency is controlled by the ratio of the coil's inductance to the composite capacitance of all four capacitors. If inductance is too low, the mid-point tracking frequency will be lower than desired, and if inductance is too large, the mid-point frequency will be higher than intended.

Since Ctrim—and in fact all trimmer capacitors—establish the minimum capacitance values present in the circuits, the effect of the trimmers is greatest at the upper end of the frequency range. Cp, the padding capacitor, on the other hand establishes the maximum value of capacitance which can be put into the circuit, and so its effect is greatest at the low end of the frequency range. This is a general rule; trimmers affect high-frequency performance and padders affect low-frequency operation.

How can we combat interference? Interference can come from many sources. Most of us tend to think in terms of interfering signals of qrm—but the hiss, sputter, and crash of a dead band in the absence of any incoming signals also interferes with anything else we may be doing while waiting for things to open up. In this section we'll look at ways to combat this type of interference as well as the more common problem of unwanted signals riding through.

The only effective way to handle too

many signals is to add additional selectivity to the receiver. This may take the form of a steep-sided filter to shave off the interfering signals, or even of audio filtering to let through only signals of one specific frequency. Such a solution is frequently used by CW hounds.

If the interference is produced by image responses or front-end overload from strong signals at far-removed frequencies, though, the extra selectivity won't do any good. By the time the signals get into the *if* stages where the selectivity can act, they're already contaminated. Use of a preselector, as we have already seen, can reduce this type of interference if it's due to image responses.

A preselector will hurt rather than help, though, if you happen to live across the street from a 50-kw transmitter and can't hear anyone but him on any band. To get rid of this type of interference you must use a filter or a wavetrap in your receiving antenna feedline. The filter will let through only those signals in its passband, while the wavetrap will remove signals on or near a single specific frequency. Fig. 9 shows the schematic of a BCB wavetrap and how to hook it up.

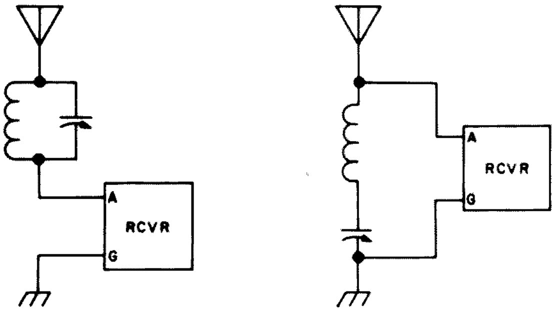

Fig. 9. Wavetraps to attenuate interfering signals and their connection to receiving antenna circuit. At left is patallel-resonant wavetrap which presents signals at its resonant frequency from going on down the line; at right is series-resonant trap which shorts out signals at frequency to which it is tuned. Both may be combined if necessary to reduce exceptionally strong signals, or to trap out two signals at different frequencies from same receiver installation.

Now let's turn our attention to that less usual "interference," the noise in a dead band in the absence of signal.

This clutter of sound is always present; a signal must come in through it, but because of AVC action it usually drops to an acceptable level as soon as a signal appears. When no signals are present, the receiver operates at wide-open gain and the roar of a dead band can quickly drive even the most steel-nerved

operator to distraction.

A number of anti-noise circuits have been developed to combat this kind of interference, and they go under the general name of "squelch circuits." All operate on the same basic principle, which is to cut off any audio output from the receiver unless a signal is present, but they achieve this purpose in a number of different ways.

Possibly the most classic squelch circuit is the CODAN; the name is a telephone-company acronym for "carrier-operated device, anti-noise" and the circuit is shown in **Fig. 10.**

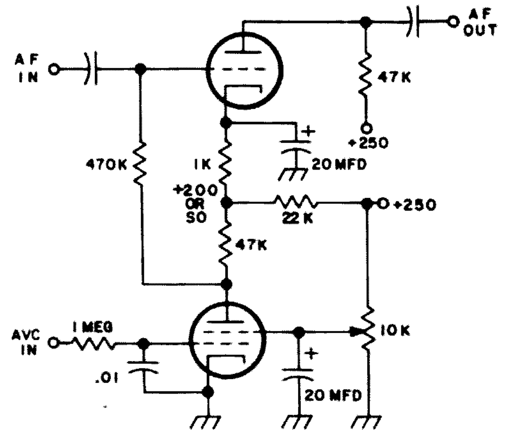

Fig. 10. CODAN squelch circuit schematic diagram. This circuit turns audio amplifier (V2) on or off by means of avc voltage applied to squelch tube (V1). Complecity and audio distortion are two major disadvantages, but circuit is still the most commonly used squelch in amateur practice.

Circuit operation is relatively simple:

In the absence of incoming carrier, the AVC voltage is zero and tube V1 is unbiassed. It can thus conduct a heavy current, limited only by its plate load resistor and screen voltage. The voltage drop across the plate load resistor produces a negative bias on the triode amplifier tube V2, which cuts V2 and prevents any audio from going through.

When a carrier arrives, AVC voltage goes negative and cuts off V1. When V1's plate current drops, so does the voltage drop across the load resistor. This reduces bias on V2 and permits the audio to be amplified. To change the amount of AVC voltage required to cut off V1 and open the squelch, the screen voltage of V1 is adjusted by potentiometer R1. This adjustment is known as the squelch level control; the lower the screen voltage, the lower the signal level required to open the squelch. In fact, with low enough screen voltage, V1 is effectively cut off with no AVC, and the circuit is locked open. This condition is used to operate without squelch action, and when squelching is desired, the adjustment is run up until the receiver just goes dead. Any increase in AVC voltage will then open the audio and permit the signal to be heard.

This circuit has several disadvantages; the largest, aside from its complexity, is that it introduces distortion into the audio because the bias on the amplifier stage depends upon the signal strength.

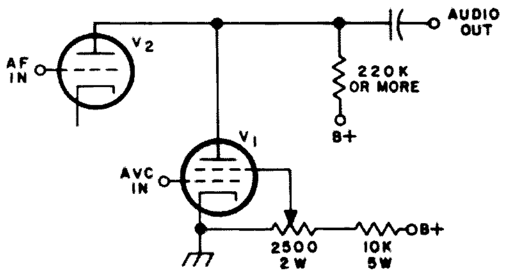

Fig. 11. Shunt squelch circuit. The design loads down audio amplifier stage (V2) by conduction through squelch tube (V1). Distortion is less than with CODAN, and circuit is simplier. In both this and CODAN circuit, squelching level is set by adjusting screen voltage of squelch tube. The higher the voltage on the screen, the more signal is necessary to open the squelch.

A simpler circuit which operates much the same but has less distortion connects the pentode stage across an audio amplifier rather than in series with it. **Fig. 11** shows the schematic. When AVC is absent and screen voltage is set high enough, pentode V1 (the squelch tube) conducts heavily enough to load down the amplifier stage (V2) and prevent audio from passing through. AVC voltage cuts off V1 and removes the load; V2 then operates normally. The screen voltage adjustment of V1, as in the CODAN circuit, controls the point at which squelching occurs.

With the rise in use of diodes for switching purposes, still another squelch circuit was developed; it has the lowest distortion of the three, and is also the simplest. **Fig. 12** shows the circuit.

This circuit uses a diode as a switch controlled by voltage levels. When the diode is conducting, the switch is closed and audio can pass through from input to output. When the diode is cut off, the switch is open: no audio can pass and the receiver is silent.

Control voltage for the diode is taken from the screen of any AVC-controlled *if* amplifier tube. In the absence of an incoming signal, AVC voltage is low and amplifier

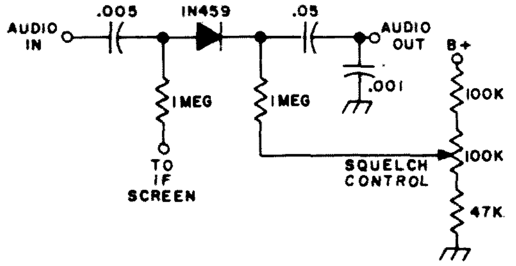

Fig. 12. Simplest squelch circuit which gives satisfactory performance is this diode-switch arrangement. Only nine components including the diode are required; existing circuitry supplies the rest. Relation of screen voltage level in if amplifier to voltage set by squelch adjustment determines squelching action. A 10-volt difference is adequate to operate the diode switch, and audio level up to 5 volts can then be passed or blocked by the switch.

current is high, with a resulting low screen voltage. When a signal arrives, AVC voltage goes negative and amplifier current comes down with a consequent rise in screen voltage.

The screen voltage is connected through a high-value isolating resistor to the anode of the diode, while the cathode of the diode is returned through a similar isolation resistor to an adjustable voltage source. When the cathode voltage is set so that it is greater than the at-rest screen voltage, the diode is then cut off. When signal arrives and the screen voltage rises, the diode turns on and lets audio through. The two capacitors merely block the dc switching voltage from the audio circuits.

This circuit introduces little or no distortion because it has no effect upon any amplifier operation; when the diode is "on" it represents merely a low-value resistance to the audio signal and when "off" it's a multi-megohm resistance.

Unfortunately, this circuit has not come into "common usage;" the CODAN remains one of the most common circuits in use despite its disadvantages.

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Now You Too Can Have A Deviation Meter

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In the world of amateur FM one of the most important test items is a deviation meter. Such a device allows the transmitter deviation level to be accurately set. Basically a deviation meter consists of an FM receiver with one of two types of visual display: meter output and oscilloscope output. The oscilloscope display method allows instantaneous deviation whereas the meter display reads average deviation. Either or both methods are relatively easy for the amateur FM'er to build and use.

The easiest method for amateur use is the oscilloscope method. However, this assumes that the individual amateur has in his possession a general purpose oscilloscope. Since this is not always the case, use of the meter method will also be outlined.

The oscilloscope method involves connection of the vertical plates of the scope to the discriminator output, as in Fig. 1. The output of the discriminator is ac voltage directly proportional to the deviation (± khz) of the transmitter. Calibration of the oscilloscope may be accomplished easily by use of three crystals. One crystal should be at the low *if* frequency of the receiver (455 khz in most commercial and obsolete commercial units used by amateurs) and the other two crystals should be either 5 or 15 khz above and below (450 khz and 460 khz or 440 khz and 470 khz) the *if* frequency. The purpose of these crystals is to set the limits of deviation. To calibrate the receiver oscilloscope combination first set the oscilloscope up for DC operation. Then set the sweep of the oscilloscope to the center of the calibrated scale on the CRT when a 455 khz (or other center frequency) is applied to the low *if*. Next apply the high and low frequency (e. g. 440 khz and 470 khz) and set the resulting line one division for each khz difference from the center *if* frequency above and below the center line. For example, set the lines 15 divisions above and below for ± 15 khz (wideband deviation) if 440 khz and 470 khz crystals are used. When deviation is read, each division on the scale will represent 1 khz. Use of the deviation display involves only "zeroing" the transmitter to the receiver and then modulating the transmitter.

An alternate method of calibration is to apply a continuous tone to a transmitter which has had its deviation set with another standard and then adjusting the height of the resulting oscilloscope pattern above and below the center line a number of divisions equal to the limits of the known deviation. However, this method is not as accurate as the former and should be used only if a standard at the *if* frequency (either crystal or variable) is not available.

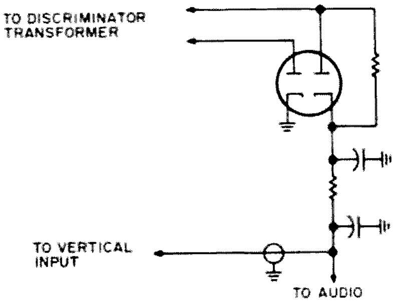

Fig. 1. Oscilloscope Display.

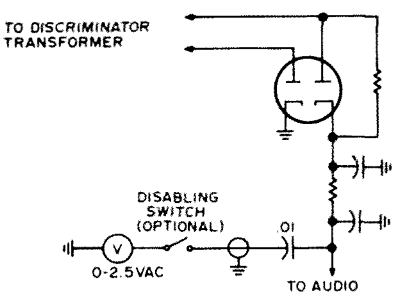

Fig. 2. Meter Display.

The second method of reading deviation (meter method) is cheaper to obtain (less than $5.00) if an oscilloscope is not available. The only drawbacks are the fact that it reads average deviation (no problem in amateur service) and the audio output of the receiver is slightly reduced. Also, an oscilloscope is necessary for initial calibration. Basically the meter method consists of an ac voltmeter connected to the discriminator output through a blocking capacitor. The meter movement may usually be of the garden 0-3 vac type, or a vom in a low ac voltage range may be used. The former is preferred so that a new scale may be added and calibrated directly in khz of deviation. The hookup is pictured in Fig. 2.

Calibration requires an oscilloscope to be calibrated as in the first part of this article. After the oscilloscope is calibrated (borrow, rent, etc., one for a day) a tone is applied to a transmitter and the deviation level adjusted to varying khz levels. The meter should be connected,. the reading noted, and then disconnected for each level. This is necessary because the meter will distort the oscilloscope level when connected. It is suggested that one khz steps be used up to 15 khz. A new scale then can be prepared and glued over the old vac scale. When the meter is connected, the audio output level will be down slightly, but most FM equipments have audio to spare when used as base stations.

An alternate method is to borrow a commercial type of deviation meter or a signal generator with calibrated deviation output and to calibrate the meter using the borrowed instrument for a standard. This method is not quite as accurate as the oscilloscope calibration, but since a continuous tone is used, the average deviation read on the standard meter will be the same as the peak deviation read on the scope. The error lies in the reading of the standard meter which is not as easy to interpolate as on the oscilloscope.

The use of the deviation meter (be it oscilloscope or meter movement type) will allow any number of amateur FM transmitters to be accurately set to an agreed upon standard (either ± 5 khz for narrowband or ± 15 khz for wideband or ± 7 to 9 khz which is usually compatible to both wideband and narrowband receivers). When care is taken in calibration, such a setup will closely approximate commercial units costing several hundreds of dollars. The major difference is that use of the meter described herein is limited to only the frequencies for which the operator has crystals (unless the receiver is tunable, which is usually not the case), whereas the commercial types are usually usable over the four major commercial FM ranges either directly or with sub harmonics. Since amateur operation in most areas is limited to a few specified frequencies, this is no drawback. Thus, this instrument can be another factor in many enjoyable hours of amateur FM'ing.

. . . K9STH

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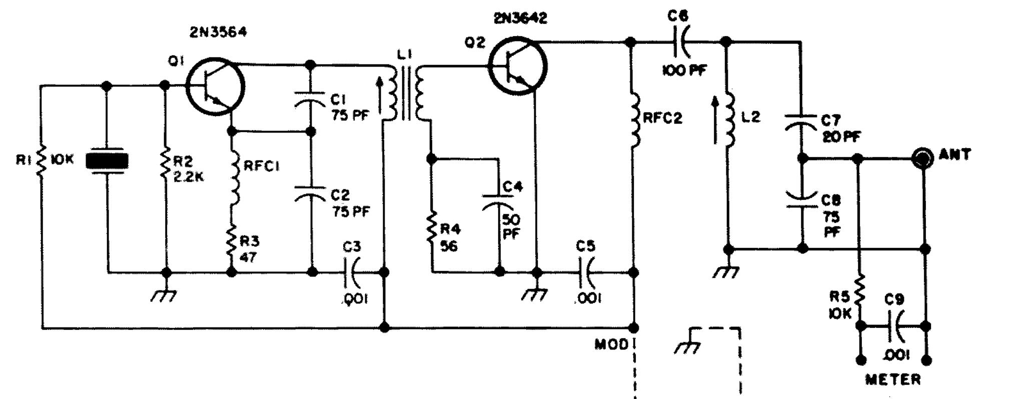
Two Transistor 1500 Mile Transmitter

Transistors being my number one hobby, I decided to try to beat some of the QRP records that others have claimed and to show what I could do with 'milliwatts' while others are building 50 and 100 watt rigs for six meters. The two transistor model has earned 'its building'. I have had reports of 10 over 9 from South Carolina, S8 from Tennessee, S7 from Arizona, and S6 from Montana, plus working all locals.

The ¼" ceramic slug tuned coil form designed for printed board use was bought from Vanguard (they advertise in *73*). The HC18/U crystals can be had from JAN Crystals (see *73*, June '67, pages 88 and 89). The modulator is a Birnbach (sold by Radio Shack and others) 5 transistor unit, with pp class B output. It has a shielded input transformer with both 50 ohm and high impedance inputs, and 500 and 8 ohm outputs. A word of caution, when I increased the voltage from 12 to 16 volts I lost the two output transistors and a 5 ohm resistor! The output is 300 milliwatts, which is enough to modulate a ¼ watt rig. The modulator has lots of gain so be sure the gain control isn't too high or you will splatter. When I tried to mount the modulator and the transmitter in the same case the *rf* got into the modulator in spite of shielding and by-passing. I gave it up. If you try this you may hear a high pitch audio whine in the receiver and find that the modulator output transistors get hot fast.

A regulated power supply (or batteries) must be used. If not, on voice peaks when



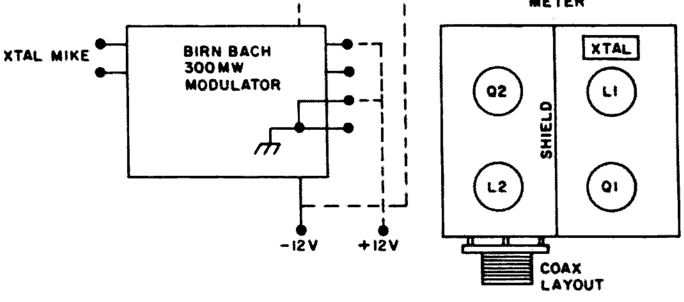


Fig. 1. Two transistor transmitter. RFC1=12 turns #26 on 1/2 watt 1M resistor. RFC2= ditto with 20 turns. Xtal=HC18/U third overtone. L1=6t #24 enam. on 1/4" ceramic iron core form, link 2t at bottom. L2=5-1/2t ditto L1. Q1, Q2=heatsinked Fairchild 2N3642's. Meter can be 50 to 200 microamp or Simpson 260.

the transmitter final and modulator stages draw current, your voltage will drop and the final result is downward modulation plus FM'ing.

In designing the transmitter, be sure all emitter and collector leads (either wiring or printed board) are very short. The shields between stages are printed board cut to size and soldered on. Make all grounds on the printed board wide (I make a wide ground all around the board and down through the center where the shield goes. See **Fig. 1.** Coat the printed board 'wiring' with solder to lower the resistance (it pays!).

Be sure the coils dip out (with a grid dipper) a little higher in frequency with the transistor out as the "extra" capacity with the transistor in will lower the frequency. You will find out (you tube boys) that in some circuits the transistor loads the coil (lowers the Q) to such an extent that you cannot find the dip. So have your receiver handy to check signals also. Also be careful, in some circuits; the oscillator transistor's not oscillating will draw more current and get hot (due to its being a class A stage till it oscillates and then it is class c). Transistors are easy to blow, ask me!

Using the grid dipper in the diode position you can check each stage to see if it is working. After the oscillator is working and the final transistor is installed, be sure the oscillator isn't loaded so it will stop. It may have to be retuned. Be sure it will fire every time the power is applied. If not, retune.

With a #49 dial bulb as a dummy load and everything connected (and working), whistle in the mike and tune the final slug for maximum brilliance and upward modulation. (I blew one bulb under modulation). Now connect the antenna and, with meter connected in output (see diagram), check for maximum output. Now check with your receiver — or better, have a ham friend a few miles away check your modulation. Set the gain control for clean audio. Don't set the gain while you are a foot or two away from the mike and then *climb* in the mike while dx'ing or you will overmodulate.

With good design, a good beam antenna, and of course, good skip conditions, you ought to do as well as I did or better. Good dx'ing.

Don't forget, in this design, that the "ground" on the transmitter is minus and the ground on the modulator is plus. Follow the diagram carefully — or, so sorry — you have ruined some transistors!

...KØVQY

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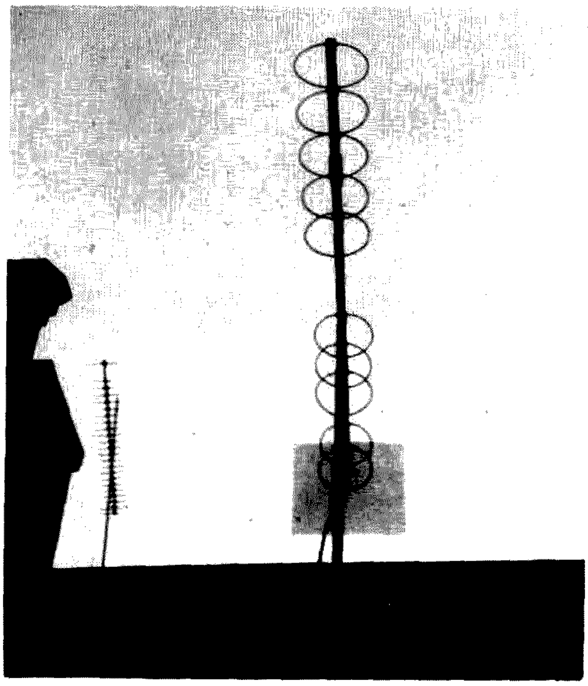
Long Circular Quads



A 23 element yagi was defeated 2:1 by the long circular quad antenna.

The 11 and 18 Element Long Circular Quads are Semi-Circularly polarized when properly fed from a one-quarter wave-length stub (or with 200 ohm balanced line) concentric in its arc with the axis of the antennas. The driven element may be fed in this manner, with a very low SWR. Polarization of any of the antennas described in this composite article can be affirmed by using a vhf/uhf field strength meter or a sensitive dipole and diode detector such as the 1N38B and a small-signal transistor dc amplifier.

By elevating these arrays to at least 17 feet[6] off ground or roof, it's possible to get a good plot of the directivity and gain. Ideally the reflector should be round and have a minimum diameter of 5/2 wave-lengths; however, a square screen 5/2 wave-lengths on a side should be adequate. If difficulty is encountered in "circularizing" the arrays from reflections or standing waves within the induction field, simply change the feedpoint from 3 o'clock to 6 o'clock, etc.

Introduction

This article gives an insight into new types of vhf and uhf antennas which are now patent pending by the author. They are usable on 2 through 3/4 meters and into the uhf television spectrum. Frequency considerations of bandwidth, patterns plotted and element tapering are discussed with curves from Project OSCAR tests and our own observations with uhf television on Channel 32. Tapering was performed on the 8 element Long Quad only. Propagation on Channel 32 was limited to a faint forward scatter signal on the premises of Radio Station WBLG, in Lexington, with their approval. The other antennas described use parasitic elements cut to the same dimensions as the driven element (DE). The round element antennas were tested in our shop as well as in the field; with precise matching on 432 mhz, with the "business end" of the array pointed up. It was found to be interesting to note that the quarterwave circular stub presented about 60° (approx. 1 radian) arc-length when unity SWR was obtained on 432 mhz. Use of RG-58/U was preferred for this band, while 300 ohm line was chosen for use on Channel 32 reception. Reception was so good that we observed about double the signal strength using the 11

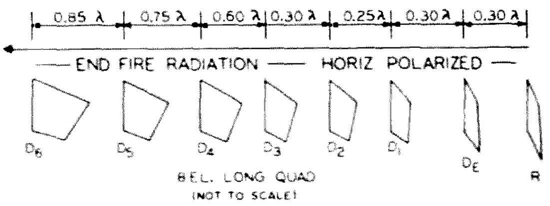
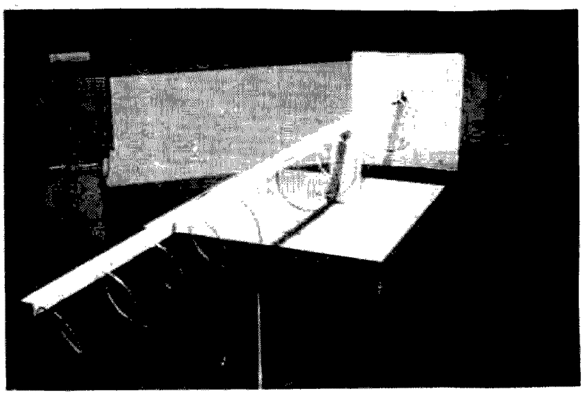


Fig. 1. 8 element long quad.

element Long Circular Quad as compared with 23 element Long Yagi built by station engineers.

The following paragraphs show without mathematics properties described. RG-9/U is a minimum size coax to be used, with preference for Foam Heliax^{tm} as in commercial installations. Silverplated RG-9/U has about the same rating as RG-8/U but has a non-contaminating jacket: and the shield-braid (2) remain interwovenly conductive within (look at your RG-8 after two years!). Both RG-8/U *and* RG-9/U are adversely affected by dew, and as much as 20% variation in reflected power can be expected, even with a perfect match! For experimental use and testing, the RG-58/U and an Amphenol coaxial termination are a necessity, mostly because of element length-to-surroundings scale, etc. Heliax^{tm} is the only answer on 100-ft. runs.



Laboratory development of the long quad.

The first photo shows the 11 element Long Circular Quad being tested with the 23 element Long Yagi in the background. Both antennas were matched to balanced 300 ohm line. The test site had a clear horizon. On the 18 element Long Circular Quad shown later, RG-58/U was made exactly 1/4 wavelength *on the outside* for proper connection from the screen (*rf* ground). Preliminary comments on the circular quads show a nearly perfect major lobe whose half-power-beamwidth gives 15 db gain over a matched half-wave dipole. This means that we can say 18 db over a point source. And these calculations were taken from the pattern itself, plotted through a research laboratory antenna range. These patterns were traced by an automatic pen recorder which was apparently servo-controlled. Some breakdown into vertical and horizontal modes were observed, but this model was not very well balanced or completely matched when tested. Calculations are accurate, since the minimum amplitude for each graph is shown to be above "zero" or presents a plotted minimum value on the same scale factor as the peak pen travel.

Also in this article, construction is detailed thoroughly for the home craftsman. Air-dried seasoned oak is preferred for the 18 element antenna 12-ft., 6-in. boom; however, a sturdy fiberglass quad arm may be better in the long run. With a heavy round quad arm, a spring brass U-bracket could be fashioned, similar to an auto radiator hose clamp with tightening pressure similar to a metal TV stand-off insulator (this would be from the underside). The other solution is to use epoxy as described fully later on.

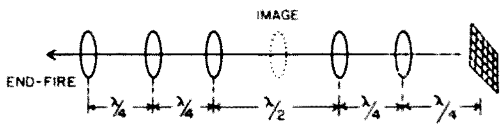


Fig. 2. Untuned reflector gives mirror image of the elements.

Long Quad Development

First in our discussion of these new antennas is the 8 element long quad of more conventional design. The approach was this: Make a regular quad with a screen reflector on the APX-6 transponder and add elements to make it "long," meaning in Yagi terms to increase the boom length with extra elements in excess of a total of 5. Using approximately 984 mhz *rf* from the transponder with a Heath Tunnel Dipper as an FS meter (diode position), we found that maximum gain and directivity was obtained with the eight elements staggered, aperiodic and quad-shaped; the directors tapered to 95% of the driven element circumference, combined to product optimum results!! All the directors were the same 95% circumference of perimeter of the DE. The elements were cut

to 984/Fmhz or at this frequency 1 foot, for convenience. The reflector screen was moved back-and-forth to match the array the first time; the second try was to build a 1/4 wave stub (shown in the quad development photo) and vary its spacing from the soldered feedpoint connections. Of course, 984/Fmhz is free-space wavelength, and we used a 4% shorter length for the DE. Unity SWR was not consistent with maximum forward gain (a corollary of Murphy's Law); so we settled for one condition consistent with near optimum with the other. The six directors were staggered as shown in Fig. 1., with the closest director spacing being between D2 and D1 (not between D1 and DE as would be expected). We claim 2 *honest* db gain over an equivalent 8 element Yagi of the same boom length, or 13 db.[1] Once we realized this array would work as described, we went further.

Circular Quad Development

The next step was to make our elements circular. The APX-6 was cranked up to about 1160 mhz, where one wavelength was close to 24 cm. and one-quarter wavelength was approximately 6 cm. We have no photo of this antenna; however, we observed that none of the expected characteristics of the long quad or long Yagi were to be found. Instead, it turned out that one-quarter wavelength spacing intervals, and staggering of our dimensions were of prime importance. The parasitic directors were cut to 95% of the DE length and odd-numbered groups of director elements, with quarter-wave intergroup spacing, gave the highest gain for the array. Also, the staggering of these groups of elements allowed a "gap" or space between for the DE and D1 reflected image to appear in phase in the right "place" on our wooden boom, for more gain. Keep in mind that the reflector was untuned and presenting an electrical "mirror image" of the elements discussed. See Fig. 2.

Polarization was semi-circular, in an axial mode (end-fire directivity) and not sideways from the boom. There was considerable horizontal radiation similar to that obtained by feeding a regular quad at its apex. Little vertical radiation was noted. Our conclusion was that some degree of imbalance was imparted by standing waves on the line or a non-perfect match at the antenna terminals.

No balun was used. The largest portion of the radiation is horizontal with an additional "circularizing effect" possible[2] because of the circular shape of the directors themselves. Also, the vertical and horizontal components are similar which makes the antenna fine for OSCAR and vhf Moonbounce work. Incidentally, "Circular Quad" is a misnomer which we use to show how the antenna was derived. With the circular quad there is no 30 db winding sense[3] loss, a characteristic of the Helical Beam Antenna. Faraday rotation, which is simply defined as rotation of an incident wave upon passage through (the Earth's) magnetic fields, should be no problem.

Mechanical Details and Performance

To prove that this antenna has promise for the amateur and experimenter, as stated in the introduction, I constructed a fringe-area uhf model of the circular quad for Channel 32, using 11 elements; and the results were fabulous. (See tabletop photo from our laboratory.) Working at 579 mhz with the driven element cut to the picture carrier, we found the gain/aperture at least equal to two commercial corner reflectors, yielding a snow-free picture of this elusive signal (see first photo). In addition, turning the array on its axis back-up a prior conclusion that we had circular polarization. The vertical and horizontal beamwidth was approximately 20 degrees.

Performance

Two lobes were reported, with gain figures based on beamwidth plotted from the *VHF Handbook*, by Orr & Johnson.[4] Note that gains of 14 db horizontal and 8 db vertical were calculated. This plot is at 5% below the normalized frequency of 1,000 mhz. At the normalized frequency, only a single plot was obtained, composed of both lobes equally (we assume) yielding 16 db power gain over a dipole. The screen reflector is about 12 by 15 inches square (not critical) and an N connector with hood is at the base of the decoupling sleeve, with RG-9B/U inside it. The SWR was high. L-shaped steel corner braces hold the N connector and base of the decoupling sleeve securely, as well as the screen.

At 5% above the normalized frequency for design-center, we have 16 db power gain over a dipole. The major lobe is clean and very little energy went into the others. The effective aperture for the array is approximately 6.5 wavelengths squared. Aperture is an interesting measure. Physical aperture of the Long Quad is twice that for any other array, I think. Or, it is like expanding a 2-wire folded dipole into a circle. We suspect the physical aperture is at least 1.4 times that of any Yagi; and perhaps as much as 2.5 times, taking into account "wavelength factor."[5] Any opinions? The equipment used consists of a two'er, a 25-watt 2-meter linear, a diode varactor and a Cesco Reflectomenter.

Performance and Theory

Assuming a standing wave of current to exist on the structure looking "down" on the vertical plane of each loop, a reflection from the imaginary "screen image plane" gives the expected 3 db gain over a single dipole. See **Fig. 3**. Based on the assumed stationary wave phase, one of several current maxima (we chose the one ahead of the sixth element) allows the amateur (or professional) to select his mounting point, depending on mast material. As the traveling wave progresses, with each peak displacing 1/4 wavelength more, gain increases. If it's difficult to visualize, simply start at the 6 db "bar" and follow the standing wave as a "point" moving from the first current negative maxima, up through zero, then positive maximum, and back to zero. The zero point on the sixth element plane is in the same plane of the bar marked 9 db, below. Observe that it is only displaced 90° *relative* to the repeating (transcendental) maxima of the assumed standing wave, which does not move. And notice that the first negative maxima referred to is positive-going, while at the sixth element the amplitude is negative-going. What's wrong? Nothing. *Both* wave motions are still from left-to-right, and add in time, giving the 9 db circular gain figure which results. In the first place, it can be asked why we picked the 6 db current bar as reference. Well, we could not use the dashed-in 0 db bar because it exists as a non-reinforced reference, without physical dimensions; however, this image *and* real element above do add to produce 3 db. This leaves the 6 db bar our choice, to eliminate confusion.

We built several models of the Long Circular Quad. After much testing and refinement of our use of instruments, starting with an APX-6 on 984 mhz, enough data was accumulated from building a uhf reflectometer and the 1000 mhz scale model that we could conclude the information presented here. Further study has led to the conclusion that the parasitic directors must be shortened a "mystical 5," as some have said, for maximum gain.

Looking back at the tabletop photo, the first group of directors from the end are all spaced one-quarter wavelength gap; then the a three-quarter wavelength gap; then the next group of three loops, each at one-quarter wavelength spacing, with a one-half wavelength gap; and on to D1 and DE, each at one-quarter wavelength. Finally, we come to the reflector (R) which is made of "expanded" aluminum and is made approximately 5/2 wavelengths, minimum, square[9]. In this model, notice that the feed-point is at 12 o'clock, with heavy 300 ohm twinlead feedline. The boom length is 3-1/3 wavelengths at 579 mhz. Estimated gain (from Gain and Aperture Nomograph[10]) is 12 db, including a 3 db polarization loss from transmitted horizontal to receiving circular. There appears to be no sense to the antenna, as there are two helices. Please note that we are looking into groups of 5, then 3, and then 2 physical one-wavelength loops from the opposite end of the boom on which rests the sheet screen reflector, R. The staggering is 3/4 wavelength gap *between* the groups of 5 and 3, with 1/2 wavelength gap between the next group of 3 and 2; and 1/4 wavelength from the DE to R. More gain can be obtained by placing 7 elements with a gap of one wavelength ahead of the 5 shown; and you can add 9 with a gap of 1 and 1/4 wavelengths ahead, if you wish: the limit is what beamwidth is practical so that you can accurately "steer" the array. Matching, as we add elements, is not a difficult problem with a DE loop configuration.

18 Element Long Circular Quad Construction

The 18 element Long Circular Quad is

mounted on a piece of 1-1/4 inch steel TV mast with U-bolts and nuts. A front "nose" brace of wood keeps the array from drooping, and it is lashed to the seasoned oak boom with filament tape. The feedline is RG-8/U, with N connectors. The boom length is 12 feet (a little short for all 18 elements); however, allowance was made for 6 inches "over-length" by crowding the elements 1/3 inch each, with no loss in performance or SWR hike. The reflector screen is connected to the boom in paddle-wheel style, using 3/4 by 3/4 inch air-dried seasoned oak as the cross members. The reflector itself is made of "expanded aluminum," 2-feet square, which is about 5/4 wavelength on a side. One very important thing about this type of mounting is that 1/4 wavelength ahead of the second group of elements is a voltage null which permits the use of a metallic support. At other distances on the boom there are nulls that can be used for U-bolting a vertical conductive support; but this position is nearest the balance-point of the array. It wouldn't be a bad idea to use a V fiberglass support arm (\Kirk J quad arm). But don't forget to balance the antenna with the coax weight on it. Foam Heliax is heavy.

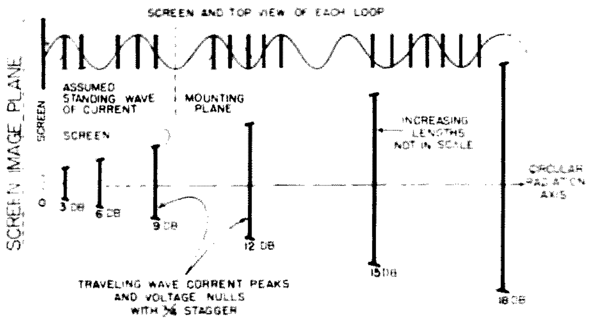
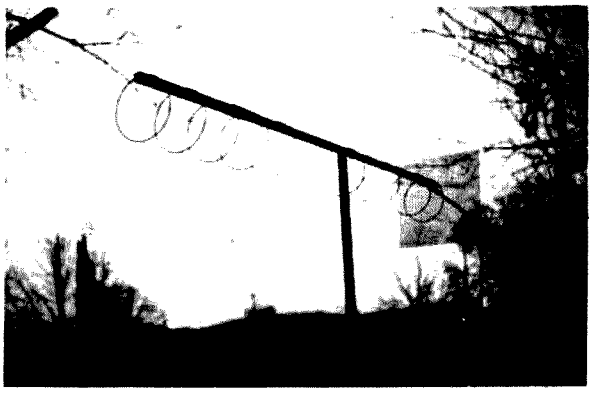


Fig. 3. Relative phase and gain of 18 element quad.

The elements were glued to the boom with epoxy, but it was first necessary to coat the rounded No. 6 hard copper with a thin layer of epoxy diluted with a very small amount of rubbing alcohol. Of course, the epoxy must be pre-mixed and the alcohol should not contain any glycerine. Prior to this, the element surface should be clean and dry and roughed-up with cabinet paper. After all 17 loops are coated, allow two days for the undercoat to dry. This method is the only simple way of gluing that works and was tested by the shipment of an 18 element 1215 mhz model to Project OSCAR group for scaled down tests at 1000 mhz (their choice for best results). Once the undercoat was dry, we inserted the No. 6 hard-drawn copper elements and gave a final coat to them and the wooden boom, which was previously drilled for 3/16-inch holes. The No. 6 cannot be bent by hand; take these elements to a sheet metal shop (pre-cut to 26 inches, as in our case), where they have a roller press just for this. Also, we tried wood riveting with the United Shoe "Rivetool," and found that by using 1/2 inch by 1/8 inch diameter steel pop-rivets, we successfully mounted the reflector screen to the paddle-wheel arms. The "pop-rivets" mentioned work only in oak. Referring to the gluing method above, we also tried the "Thermogrip Glue Gun," and it was not satisfactory; nor was our "Eastman 910 adhesive." 910 won't stick to wood, but it's



II element long circular quad antenna.

great for ceramic spacers on steel, rubber, etc. If you wish to be sure . . . use No. 8 self-tapping sheet metal screws into the oak, with 3/32-inch pilot holes. This is perhaps the safest, since rivets can crack the oak if not properly centered on each side.

A semi-closeup of the Long Circular Quad with leads to equipment is shown in the photo. This time we had a 4 to 4 quadfilar transformer on Ami-Tron T-50-10 core with poor results. The SWR was no lower than 2:1 on the reflectometer. Using Foam Heliax^{tm} is preferred to RG-8/U. An Amphenol or Andrew coax termination should be used for properly balancing and matching the one-radian electrical length of the circular stub. Total length of the circular stub and balun section is 90°, or one-

quarter wavelength (we used 6.5") of No. 12 tinned copper, with 30 of the 90°, approximately, being used for balance. Reiterating: Just ahead of the first group of three parasitic elements (but behind the helper's hand) is *the* first complete null for mast mounting with metal U-bolts and clamps. With a sturdy fiberglass mast, the mount can be made anywhere on the boom not contained within a group of elements.

Conclusion

Looking back, there are several points which should be summarized: (1) The Long Quad is semi-circularly polarized when correctly matched and thoroughly *balanced*, with some breakdown into vertical and horizontal lobes which can occur when the antenna is held less than 17 feet[6] above ground; approached with less than 50 feet from the measuring site, and used too far below design-center. With 1.00 to 1.05 on the reflectometer and no standing waves *on the outside* of the feedline, it is semi-circular,[8] at least relative to the reflecting screen. (2) The gain of the array, when considering a boom length sufficient to hold 27, 38, or 51 elements (which are the next groupings of elements) places it in the category of a small dish, but with less physical aperture. (3) Frequency limits of +5% and -10% make it useful over a band of frequencies, and the loop wavelength can be calculated by 24,500/Fmhz, with lengths in centimeters. This formula is for a one-wavelength loop, physically. (4) There is no winding sense rejection such as characterizes a Helix; and a single support arm through the reflector screen material may be used with a counterweight to aim properly.

Try these arrays out in your own shack . . . get it matched *before* buying a pair of TR-44's on our say so. Crank it up 17 feet, balance it, and using **Fig. 3** (extrapolated) as a guide to the nulls and gain with more elements, pick your mast position with RG-8/U cable taped on the boom for mechanical balance, then try the Foam Heliax (you might try the Phelps-Dodge Aluminum Foam-Flex which may be even better.) For an in-the-air mount, use an aluminum Y hanger from a separate U-bolted clamp with old garden hose binding the clamp to the upper portion of the mast. Good 432'ing!

. . . W4KAE

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6. Loren Parks: *VHFer*, Issue No. 8, Vol. 4, page 8, Nov.–Dec., 1966.
7. E. P. Tilton, WIHDQ: "The L-Match," an unpublished proof to W4KAE.
8. Opinion expressed by Dr. John Kraus, December 6, 1966: "loops of wire as elements should have a circularizing effect," as paraphrased.
9. *The Radio Amateur's Handbook*, 42nd Edition, 1965, page 463.
10. Orr & Johnson: *VHF Handbook*, 1956, pages 96-97.

(continued from page 2)
trend in amateur licenses. Nothing was done about setting up a small office in Washington for someone, even on part time, to lobby in Congress for our hobby. A second meeting is scheduled for November this year, so those few amateurs who are interested in their hobby have another chance this year to get the directors of the League to get off dead center.

There goes Wayne again, lambasting the League! No, I'm not anti-ARRL at all, only pro-amateur radio. All of you have put your eggs in one single basket: the ARRL. If there are any reasons whatever for amateur radio not paying for some national publicity I would welcome them and give them space in 73. If there are any reasons why amateur radio should have fewer amateurs instead of more I would like to know what they are. I know a lot of reasons why we should have more amateurs and why we need publicity and need it desperately, but I sure have yet to hear anyone speak up in QST or anywhere else and give reasons why we should not try to grow.

Along the same line, I have heard many reasons why amateur radio should have a working lobby in Washington, but I have yet to hear a single reason against it. Yet year after year we don't have one. Will someone, anyone, please write an article for 73 explaining why amateur radio should be the only radio service with no protection in Washington?

What did the directors accomplish? Well, for one thing they decided to petition the FCC to open the 29.5-29.7 band to Techs. We do need more activity up there, no question about it. Perhaps, since the only real difference between the Tech and the General license is a matter of code speed, this is the break-through that Techs have been waiting for and which will eventually get them a foothold on all our lower bands. I would think that there might be a survey taken to ascertain the activities of the Techs. How many of the active amateurs on 1296 are Techs? What percentage and how many on 432? On 220? On two meters? On six? There are some 60,000 Techs today. I think we should know how many are active, and what bands they are using at present. If we open ten will it siphon off everyone from six meters? Or will it just make for more activity in total?

The directors directed the ARRL to petition the FCC to open the remainder of two meters to Techs. This is long overdue, as I mentioned in an editorial several years back. I don't know why no Tech has taken the effort to petition the FCC for this change. This would integrate the band and eliminate the second-class citizen feelings of Techs who hear the Generals working aurora, CW, contests and satellites down on the low end of the band, unable to really join in the fun.

They directed the League to petition the FCC to reduce the waiting period for Extra Class to one year from two. This is probably a good idea too, but I doubt if it will have much effect on the massive resistance to the Extra Class we have seen so far.

They directed QST to start publishing info on VHF repeaters, put out a booklet on the subject, and get it into the Handbook. Great, but why was a board directive needed to get QST to this important phase of our hobby?

The $100,000 fund for amateur radio promotion worldwide was refunded. Excellent, But am I being rotten to suggest that some of the members may be interested in accounting of funds already spent? Nothing whatever has been published that I recall seeing. Where there is secrecy there is usually a good reason for it. Or does anyone else care where the money is going?

Dialog in 73?

Though I have written quite a few provocative editorials down through the years, I have had few letters as a result that were worthy of publishing. Sometimes I wonder if there is anyone out there. Isn't there anyone that has the hankering to write an editorial among our readership?

How about opening 3650 - 3700 for phone operation? I would suggest 3750 - 3800, but then the ten Canadian phone stations that operate in that band would get all upset and descend on me as a newly born devil. No, let's leave those VE lads their own private perserve to sit and talk with their own and QRM the hapless European and African stations that try to work through to the U.S. How about a nice phone band

down below the Novice segment? Why? Why not?

Or perhaps it is time to extend the U.S. phone band down to 14,150 mhz? That still leaves plenty of room for the foreign phones that want to avoid contact with U.S. stations to operate from 100 to 150. Does anyone care one way or the other? Write to 73. Write to the FCC with 14 copies. Do something!

Do any of these things ever get discussed at club meetings? Come on, fellows, let's not spend the entire meeting reading the minutes of the last meeting. They are going to install a VHF beacon at W1AW. How does that strike you? Do you care one way or the other? If not, then why should they spend your money for such a thing? If VHF beacons are needed, why hasn't anyone written about it? There is a grave communications gap here.

What do you think of having our radio clubs examine prospective amateurs instead of FCC? And how about our clubs sending a representative each year to the National Convention to represent the members and come up with proposed changes in our regulations and allocations? You like the idea? You hate it? How about some dialog? The pages of 73 are as wide open to you as they are to me. With the expanded magazine we have a lot more room for opinions and such.

Radar Trap?

Jake, WB2PAP, sent in a newspaper clipping that makes life a little more worth while. It seems that a chap down in Madison, New Jersey was stopped for speeding (41 mph in a 25 mile zone) in a radar speed trap. "$16" (dollar a mph) said the judge, "plus $5 court costs." The victim, being a ham, decided to check a little. Sure enough, he found that the license for the radar had expired, a matter that could bring a $10,000 fine, if someone decided to file a complaint. If I were the judge I think I would have a strong tendency to agree with the victim that the 25 mph speed limit was unrealistic.

Visit to Quement

Just south of San Francisco, in San Jose, I found a mammoth radio store. I realize that they do everything big in California, but this is stretching things! Though he doesn't

make much of it in his ads, Frank Quement has a corking good ham department. Quement is probably best known around the country for his swr bridges, which he has sold by the thousands via mail order. Frank, I found, takes a great interest in amateur affairs and is ready to talk ham the minute you can pry him away from the salesmen and reps that hound his footsteps at every turn.

Visit to Jennings

Having a few hours before my plane back east, I hopped into a rented car and hied myself to Santa Cruz to drop in on Ozzie and Jo. By now you must have seen their ads.

They have pretty well filled their medium sized plant already and were working over plans for a new and bigger building when I arrived. After looking at the mountains of diodes they have on hand I see no reason to question their claim of the largest collection of diodes in the world. They showed me the testing machines that run curves for every diode they turn out.

Their ads claim that they can make up rectifiers for any application. Ozzie showed me some welding rectifiers that would handle a thousand amps. . .and others in remarkably tiny packages that would handle thousands of volts. They are turning out little plug in units that will replace any of the common tube rectifiers as a direct substitution. These are imaginatively and attractively colored. I'm hoping that they will be able to line up a bunch of them for a beautiful color cover

shot for 73. The 5Y3 replacement is small . . .the 5U4 a little bigger. . .the 816 replacement still a bit larger. ...the 866 is about the size of a 5Z4. The 872 is about 6L6 size and the 575 replacement is almost 866 size! All are ready to just plug in and solidly epoxied.

From what I could see, Ozzie Yeager and Jo Jennings have established a firm beachhead as the kings of diodes and rectifiers. Purchasing agents have already begun to find the way to their door and it looks to me as if they should be about ready for an enormous growth in sales. I don't think that they even realize the potential.

They have an interesting little vacuum antenna switch package about ready for production now too. This, too, could have a profound effect on amateur radio. Imagine a vacuum antenna switch at not much more than a good coaxial switch! The UHF crowd should be the first to grab this break-through Eventually we may see them built into most linear amplifiers.

We can also look for Jennings to market some of those fabulous Jennings vacuum variable capacitors. . .but at amateur prices. Now and then, in the past, a handful of these jewels would break loose in surplus, but they never were available for long.

Keep your eye on Jennings and watch their ads for some startling new ideas.

Outgoing QSL Bureau

With the exception of the ARRL, virtually every national amateur radio society in the world provides an outgoing QSL service for their members. It is not a difficult or expensive service to provide since most of the cards just have to be sorted into a couple of dozen boxes to be bundled and bulk mailed to other QSL bureaus.

If we neglect the cost of the QSL card itself, which is not an insignificant item, and just consider the postage involved, we may be surprised. The average 73 reader makes well over 100 contacts a week, which comes to about 5000 a year, unless he likes contests, in which case his total can be easily double that. Card postage costs 5¢ in the U.S. and Canada and 8¢ elsewhere. If you figure that 20% of the contacts are DX, the bill would come to $80 for mailing the DX cards and $200 for mailing domestic cards: $280 a year. It would seem that the members of amateur radio societies in other countries are getting quite a lot more for their membership fee than we are in the U.S.

Not a few ARRL members have become aware of this unnecessary expense, but somewhere between their director and final action by HQ the matter has always come to a dead end. Asked recently about this, John Huntoon is alleged to have explained that the League is afraid that the drop in postal revenue to other countries might cause difficulties.

The mailing of QSL cards in bundles to foreign QSL bureaus is entirely legal and there seems to be no real reason other than pure laziness, according to those that are intimately familiar with the situation, for a society not to provide this valuable service. And it is a valuable one, there is no question about it. Neglecting the domestic cards for a moment, if the 80,000 ARRL members each spent our estimated $80 per year on QSL postage, that would amount to $6,400,000 per year!

That seems like a lot and something certainly should be done to cut out this waste. One amateur who has grown increasingly concerned over the situation is Lloyd Colvin W6KG, who probably has one of the largest QSL collections in the world. He certainly has the largest one kept in order in file cabinets. Lloyd first put what pressure he could on his director and then on ARRL HQ, but he was able to get nowhere. Being more than average in obstinacy, he decided that dammitall he was going to do something about it. Thus started the World QSL Bureau, which has been advertised recently.

For 3¢ each Lloyd will handle all of your domestic QSL cards: foreign are only 4¢. Right there the postage costs of sending cards is just about cut in half. If the 100,000 or so active amateurs spent only half our above estimated postage per year this would come to some $14,000,000.

Lloyd also has a nice scheme for printing QSL cards in bulk at a very low rate that should be of interest. When cards cost 5¢ to 10¢ or even more each, many of us are a bit cautious about sending them out unless they are persistently asked for.

Lloyd and Iris, his lovely wife, may turn out to be two of the best things that have ever happened to QSL'ings.

Lloyd Colvin (W6KG) and Iris in the World QSL Bureau office. Note the dozens of QSL card storage bins used for sorting cards to be sent to QSL bureaus around the world.

Recently, while in the San Francisco area on the Don Miller case, I had the opportunity to get together with quite a number of the Northern California DX Club at the home of Don Schliesser WA6UFW. I enjoy getting a chance to meet devoted Wayne Green haters and Don managed to get one or two to turn out. After I explained the difference between what I have written in 73 and what they had heard that I had written, tensions eased considerably. I recognize that one of the problems is that I am much too brief in my editorials and that many of my ideas don't come across well in this format. But I can't take an entire issue of the magazine and fill it with editorial. . .and this is essentially what happens when I speak to a club. They get a hundred or so pages of material all at one time and I have the opportunity to explain my ideas at better length and develop them in logical order.

Lloyd and Iris were at this meeting and I had a chance to stop by and see the famous W6KG QSL collection after the meeting. . . and to see first hand the World QSL Bureau which they have set up on the first floor of their apartment building.

Lloyd, retired from the army a few years ago, has gone into the building contracting business and has done very very well at it. He and Iris wrote a book which my contracting friends tell me is the best book ever written on the subject, *How We Started Our Own Home In Our Spare Time and Went On To Make $1,000,000 in the Home Construction Business.* This book is available from the Radio Bookshop postpaid at the regular price of $6.95. . .or can be ordered from your local bookstore. Radio Bookshop, Peterborough, N.H. 03458.

Lloyd took me through the World QSL Bureau and explained how it worked. He and Iris have a beautiful setup there and they should be able to save U.S. amateurs hundreds of thousands of dollars. . .or more. Their club plan passes along a nice slice of this to clubs. . .club secretaries please take note. Lloyd explained how he will soon be able to provide QSL cards at a very low cost by ganging up a simple type of card on a large offset press and printing a few hundred of many different cards all at once. Clever idea.

Radio Series

"QSO with W2CFP' is available on tape for any radio station interested in broadcasting a series on ham radio. Write to Dave Flinn, W2CFP, 10 Graham Road West, Ithaca, NY 14850 for info.

There seems to be a strong tendency for old timers to color their memories of amateur radio's past glories and for newcomers to idealize the olden days. Bunk. The old timers, with very few exceptions, built only what they absolutely had to and few of them understood much of what they had done when they got through. They built their rigs from articles in Radio or QST and put out the most horrendous signals you've ever heard. The hams of yesteryear were nice guys. . .but then almost everyone was a nice guy in those days. . .and the intelligence was about the same as today. I have seen no data whatever that suggests that higher grade licenses result in more consideration on the air. Some of the very worst offenders are refugees from old folks homes. Why, there is one old timer out in California that gets on twenty meters and makes most of the CB channels sound like Sunday school. He is a Bad Xample. The First Phone, which I passed, didn't seem that much different than our blessed Extra Class exam. I suspect that we must look elsewhere for the reasons for bad manners on the bands. We may be suffering from the same blight that has hit our

schools, our cities, and our whole society. This seems to be a world-wide phenomenon, and seems worth some study. Can we blame Spock? The bomb? Or sunspots?

FLASH!

Navassa is open for business again.

The State Department informed us that henceforward any and all amateurs interested in visiting Navassa may do so, provided they obtain prior permission from the Coast Guard. This permission will be given if you can assure them that you will not require rescue.

I suppose that someone will rush right down there and take care of the need that has built up since a few of us operated from there back about ten years ago. I sure would like to get my old KC4AF call back again and get on for a few days from there. Perhaps we should work up a giant DXpedition of all those interested in going and go down enmasse?

...Wayne

Homebrew Genealogy

Have you ever built a piece of gear out of a book or magazine, used it for a few years, and then found that when you wanted to repair or modify it, you had forgotten its exact parentage, how it worked, or why? Have you ever spent the entire evening trying to go through a 20-year collection of magazines looking for that same article without stopping to read all the other interesting articles you ran across? Join the crowd!

On your next trip to the stationery store buy a small package of pressure-sensitive labels. The next time you build something, pencil in any changes from the original on the diagram. Record the magazine name, issue, and the page number on the label and put it on the equipment in a spot which is easy to see. This way you can quickly get your project out of the way and spend your spare time reading those articles without feeling guilty.

William P. Turner, WAØABI

Tubes to Diodes — Pep Up a Lazy Rig

Through a little research, experimentation, and a few shocks, I have found that old rigs can be considerably improved with very little time and trouble. Your receiver will be more sensitive and your transmitter will sound cleaner if you just give 'em a little more voltage. Most of the components are conservatively rated, so it shouldn't hurt.

How? Throw away (into the junk box) those old rectifier tubes! This is the age of solid state and miniaturization. Use diodes. The lower internal voltage loss puts more on the plates, which in turn puts a little more in your speaker or antenna. Their small size and versatility make them adaptable to almost any situation. And they don't need filament power. And they don't have to be replaced as often as tubes either. Here are a few ideas for you.

6BW4 – Instead, use two Sylvania F8 (or similar) diodes. Solder them between pins 7 and 9 and pins 1 and 9. Use a heat sink and *be sure to observe polarity!* Transformers ain't exactly cheap!

6AL5 – Use two general purpose diodes such as 1N198's. Solder them between pins 2 and 5 and pins 1 and 7.

Poly Paks (Box 942, Lynnfield, Mass, 01940) sells direct plug in units of diodes to replace tubes. OZ4, 3DG4, 5U4, etc., and 6AU4 are $2.40, the 5R4 is $4.40, and the 866 unit is $10. Add 25¢ for postage and handling. No, I don't work for them, I just recommend them.

When done correctly, these modifications work quite well. A little hint: always use a high PIV and you'll never see that whiff of blue smoke from the power supply.

Be careful when using a diode fed output monitoring circuit in a transmitter, such as those found in the Twoer and Sixer. They can cause TVI and they do bleed away some power.

Some more of this type of valuable information can be obtained from the "Diode Circuits Handbook" by WA1CCH, available for $1.00 from 73 Magazine.

Paul Snyder WA3HWI
Philadelphia, Pennsylvania

Measuring FM Receiver Noise Figure

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Much has been written about the use of noise generators for noise figure measurement of AM receivers, but the available information on their use with FM receivers is scarce. The purpose of this article is to discuss briefly the theoretical aspects of noise figure measurement of FM receivers and then to show a practical, experimental method for accomplishing this result. The method to be described can also be used to improve the accuracy of AM receiver noise figure measurement.

In order to keep the discussion short, it will be assumed the reader is familiar with noise generators and their application to AM receivers. A complete, detailed description of the theoretical and experimental aspects of FM receiver noise figure measurement can be obtained from the author upon request.[1]

Noise in FM Receivers

The noise generated in the front end of an FM receiver has the same characteristics as the noise generated in the common noise generators such as the temperature-limited diode,[2] microwave diode,[3] gas-discharge tube,[4] and a thermal source[5] such as the Monode noise generator.[6]

One characteristic of this type of noise is that it is random; i. e., the amplitude of the noise voltage (or current) is unpredictable, meaning that if the noise voltage is known at some instant of time, the value at some time in the future cannot be predicted. This is unlike the more common functions such as a sinusoidal voltage where, once certain simple facts such as the frequency and peak amplitude are known, the instantaneous value of the voltage can be predicted for any future time.

Random noise generated within most electronic devices such as transistors, tubes, and resistors can be considered to contain all frequencies of the spectrum; the term "white noise" is used to describe this characteristic. Actually, not all frequencies are present in what is ordinarily called white noise because there is always some upper frequency limit resulting from transit-time effects, energy considerations, or stray reactance, but in most cases the strays, etc., occur at frequencies far removed from the frequency range of interest so the noise approximates true white noise. When passed through the tuned amplifiers in a receiver, most of the frequency components are filtered out leaving only those frequency components coinciding with the pass-band of the circuit. In spite of this frequency-filtering process, the amplitude variations of the noise still have the same random distribution possessed before the band-limiting; i. e., it is still a random noise, it just has a narrower bandwidth.

In an *rf* or *if* amplifier the band-limiting or frequency-filtering process is independent of the amount of noise present. Therefore, when the noise present in a receiver is increased by applying a source of white noise from a noise generator to the antenna terminals, the amount of noise appearing at the output of the *if* stages will increase but the frequency content will remain the same.

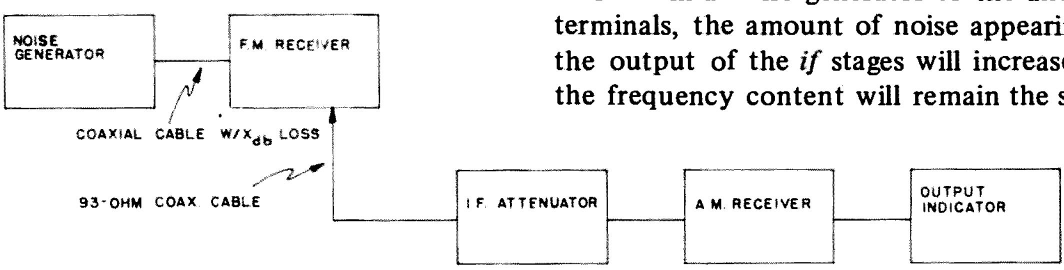

Fig. I. Block diagram showing arrangement of units wnen measuring the noise figure of an FM receiver. Parts List: C_1 – 0.1 uF Disc ceramic: CO – 100 Volt DC relay with 1 Form C contact; J_1, J_2 – Amphenol 83--1R Coaxial connectors (SO–239); R_1 – 27 Ohm, 1 Watt, 5% Carbon; R_2 – 12 Ohm, 1 Watt, 5% Carbon; R_3 – 6.8 Ohm, 1 Watt, 5% Carbon; R_4 – 47 Ohm, 1 Watt, 5% Carbon; R_5 – 1K, 1 Watt Carbon; S – 1 Pole, 5 Position, Non-shorting rotary switch.

In a good FM receiver there are at least two limiter stages preceeding the discriminator. Usually the limiters are "hard-limiting" meaning they are slicing the incoming noise at an amplitude much less than the average value. Normally, there is so much gain in the receiver that the limiters are hard-limiting even with no external noise applied to the FM receiver. Consequently, the maximum amplitude of the noise signal appearing at the limiter output is constant regardless of the amount of white noise applied to the antenna terminals. The frequency distribution of the noise at the limiter output is random and is related to the bandwidth of the receiver.

The output from the discriminator is proportional to both the amplitude and the frequency of the signal applied to its input. Because the noise is amplitude-limited by the limiters, and frequency-limited by the *if* transformers, and because these limiting processes are independent of the amount of noise present, the noise output from the discriminator (and the audio system) will not change when a noise generator is connected to the antenna terminals. This means a noise generator cannot be used in the manner in which it is usually employed with an AM receiver.

The test setup

Because of the nature of noise, the amount of noise can be detected in any convenient manner and the noise performance of the receiver relative to its internally-generated noise will be established. A simple method for determining the amount of internally-generated noise consists of providing the FM receiver with an AM detector at some point before *any* amplitude-limiting takes place. (A little care is required to be sure no limiting has taken place prior to the AM detector.)

Fig. 1 is a block diagram illustrating the arrangement of the noise generator, the FM receiver being tested, an *if* attenuator, the AM receiver acting as an amplifier-detector-amplifier, and an output meter.

The output of the noise generator is connected to the antenna terminals of the FM receiver being tested. The noise output of the noise generator should possess the proper randomness of amplitudes and it should contain frequency components that are constant over a range larger than the pass-band of the *rf* section of the FM receiver. Any of the noise generators mentioned previously are suitable.

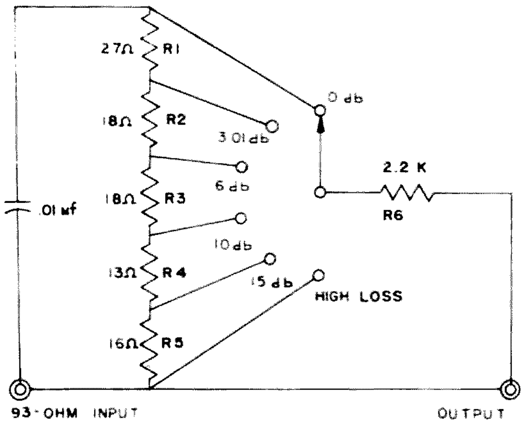

Fig. 2. The 93-ohm if attenuator. R1 thru R5 are the nominal values of 5% carbon resistors; if more accuracy is required, see text for exact values. Parts List: C_2 – 1000 uF, 6 Volt Electrolytic (see text); D_1 to D_4 – 1N34 Diodes; M – 50 uA Meter; R_6 – 22K, 1/2 Watt Carbon (see text); T_1 – Universal output transformer

The *if* attenuator is connected to some point in the FM receiver *if* system before the limiters. The best place seems to be the plate lead of the last high *if* stage. This point is preferred because the signal at that point is relatively large but has not been amplitude limited. The output of the attenuator is connected to the antenna terminals of the AM receiver.

The AM receiver can be practically any receiver capable of being tuned to the *if* of the FM receiver. It is preferable to have an *rf* gain control on the AM receiver because this permits selection of the detector operating point. We have used successfully a Hallicrafters S-38 and a modified Heath GR-54. The output of the AM receiver is connected to some form of output indicator.

The output indicator can be a simple rectifier-microammeter combination or an ac vtvm. The major requirement of the output meter is that it be average- or rms-reading and not peak-reading This eliminates most vtvm's because they are peak-reading although the scales are marked in volts, rms. The meter must also have a long time constant. A Heath IM-21 is an average-reading meter and is excellent for use as an indicator if its time constant is increased by

placing a 500 uf capacitor across the movement.

The attenuator

When measurements are made on any system, the most important items are the signal source and the output indicator. The most common source of error in noise figure measurements is the noise detector. This error results from the generally-unknown detector characteristics in the receiver being tested (usually the detector is assumed to be linear but is actually square-law, giving, as a result, noise figure values that are much better than they actually are). In the method of measurement being described here, the burden of measurement accuracy is placed upon the *if* attenuator.

The schematic diagram of the *if* attenuator is shown in Fig. 2. It is a simple voltage-divider type having a 93-ohm input impedance. It gives six steps of accurately-known attenuation; 0.0, 3.0, 6.0, 10.0, 15.0, and some value greater than 40 db at 10 mhz (the last step isn't accurate and doesn't have to be). The actual attenuation is not known and is not relevant. Resistors R1 thru R5 are mounted on a good-quality rotary switch using the shortest lead-length possible. R6 is used to provide a relatively high load impedance to the attenuator independent of the input impedance of the AM receiver; its value is relatively unimportant but should be at least 2.2k. The capacitor is used for dc blocking. The entire unit should be mounted in a Minibox or similar shielded housing. A piece of RG-62B/U or similar 93-ohm cable with a connector on one end and clips on the other end is used to connect the attenuator to the receiver being tested.

The secret of the attenuator accuracy lies in the form employed. When attenuators of the T- or Pi-type are used, their accuracy is critically dependent upon the source and load impedances presented to them. The impedance of an *if* amplifier or the antenna terminals on a tunable receiver are nebulous. Because of this, when T- or Pi-type attenuators are to be used it is recommended that at least 60 db of attenuation be placed on each side of the attenuator in order to present a reasonably-well known impedance to the attenuator in question.[7] In addition, if the attenuator is to be variable, three elements must be changed for every step of attenuation. For noise figure measurement only relative attenuation is important. Therefore, a voltage-divider type is ideal.

If 5% carbon-composition resistors having the values shown in Fig. 2 are used, the attenuator accuracy will be much better than that of the average AM receiver diode detector. However, if more accuracy is desired it can be obtained by one of two methods. Which method is used is dependent upon the type of noise generator to be employed when making noise figure measurements. The methods are:

1) Determine the actual attenuation values after the attenuator is built and mark the switch positions with these values, or

2) Trim the resistors to the exact values required for steps of 3.01, 6.0, 10.0, and 15.0 db; the exact resistor values are: R1 = 27.2, R2 = 19.2, R3 = 17.2, R4 = 12.8, and R5 = 16.6 ohms.

The first method is difficult to do directly because precise vtvm's at *if* frequencies are rare. However, an indirect method can be employed by measuring the resistors with a Wheatstone Bridge and calculating the expected loss from the dc values. So long as good construction practices are employed and good non-reactive resistors such as Allen-Bradley type EB, ½-watt, 5% carbon, are used, the calculated losses should be accurate.

The second method requires some means of determining the dc resistance and is therefore similar to the first. Precision resistors can be used, so long as they are non-reactive, or the Allen-Bradley resistors can be used with their values "adjusted" by selecting individual resistors from a batch or by filing.

If a variable-output type noise generator such as the 5722 diode is used when taking noise figure readings, the "3 db" step should be exactly 3.01 db. This would indicate that the second method should be used. If a fixed-output noise generator such as the Monode is to be used, the first method is acceptable. The attenuators we built were calibrated and adjusted using a combination of the above techniques. A quantity of Allen-Bradley resistors were obtained and the values selected to give a 3.01 db step and to make the rest of the steps as close to the

desired values as was practical consistent with not too much work. For example, one attenuator came out with steps of 3.01, 5.9, 9.8, and 14.9 db.

Making the measurements

Connect the components as shown in **Fig. 1**. The cable between the noise generator and the antenna terminals of the FM receiver must have a known amount of attenuation. The input of the attenuator is connected to the FM receiver *if* system by connecting the braid of the RG-62B/U coaxial cable to the chassis of the receiver and clipping the center conductor over the insulation of the plate lead of the last high *if* stage.

Set the attenuator to give 0 db relative loss. Disable the agc in the FM receiver, if so equipped, and disable the avc and the anl in the AM receiver. Tune the AM receiver to the *if* frequency of the FM receiver. Set the *rf* and *af* gain controls on the AM receiver to give nearly full-scale deflection on the output meter. Set the attenuator to the high loss position. The output meter should go to zero. If it does, the equipment is ready for measurement. If it does not there is insufficient shielding or the AM receiver is too noisy, and the condition will have to be corrected.

The remainder of the measurement discussion is divided into two parts according to whether a variable- or fixed-output noise generator is to be used.

A variable-output generator:

The detector in the AM receiver should be as non-linear as possible in order to give the largest change in output indication for a given change in noise level. The detector operating point is adjusted by using a low *rf* gain setting and a high *af* gain setting on the AM receiver. If possible, set the detector operating point to give a 6 db change in output when a 3 db change is made in the attenuator setting. When adjusted, set the attenuator to the high-loss position and note the output from the AM receiver. It should go to zero. If it does, all is well and the attenuator can be set back to 0 db relative loss and the measurement may proceed. If it does not, find out why not and correct the difficulty.

Note the noise level indicated by the output meter. Set the *if* attenuator to 3.01 db relative loss and increase the noise generator output until the output indicator reads the same as it did with no noise applied and the attenuator set to 0 db relative loss. The FM receiver noise figure is found by means of the formula: NFdb = ENdb - Xdb, where EN is the excess noise of the noise generator and X is the loss of the coaxial cable connecting the noise generator to the FM receiver. If directly connected, X is zero.

A fixed-output generator

The AM receiver will have to be calibrated. This can be done by varying the attenuator and noting the change in the output indicator reading. The *rf* and *af* gain controls on the AM receiver are adjusted to make the output indicator reading change the same amount as the attenuator setting is changed. Once the receiver is calibrated, the measurement procedure is as follows: Connect a "quiet" termination to the FM receiver antenna terminals thru the same cable used to connect the noise generator to the receiver. Set the *if* attenuator to 0 db. Note the output from the AM receiver. Connect the noise generator to the FM receiver in place of the "quiet" termination. Note the increase in output from the AM receiver. The noise figure of the FM receiver is found from the formula: $NFdb = ENdb - Xdb - 10\ \log_{10}(Y - 1)$, where En is the excess noise of the noise generator, X is the loss of the coaxial cable connecting the noise generator to the FM receiver, and Y is the ratio of the output power from the AM receiver with the noise generator connected to the FM receiver to the output power from the AM receiver with the "quiet" termination on the FM receiver. Some of the burden of the output change can be taken up by the attenuator. This is done by increasing the attenuator setting when the noise generator is applied and calling the change in output the sum of the attenuator setting change and the output meter reading change.

It is advisable to listen to the noise output from the AM receiver while taking the measurements in order to detect signals that will cause erroneous results.[8]

Measuring AM receiver noise figures

The techniques described can be applied to an AM receiver as well as an FM receiver. The accuracy of measurement will be much better than it is with the "usual" technique because the *if* attenuator is used. The noise generator is connected to the AM receiver being tested and the input of the *if* attenuator is connected to the plate of the last or next-to-last low *if* stage. Of course, the AM receiver used after the attenuator must be able to tune the *if* of the AM receiver being tested.

Summary

The noise figure of an FM receiver cannot be measured in the "usual" manner because of the nature of FM receivers. However, it is possible to measure the noise figure by employing an AM receiver as a noise detector. Measurement accuracy can be improved when measuring the noise figure of FM or AM receivers by employing a simple, accurate *if* attenuator. The attenuator was described and the technique using the *if* attenuator was given.

Further information on noise generators and the general technique of AM noise figure measurement can be found in references 2 and 6 and in Rheinfelder.[9] A very interesting discussion of noise appeared in *73 Magazine* in January, 1967.[10]

. . . W8BBB

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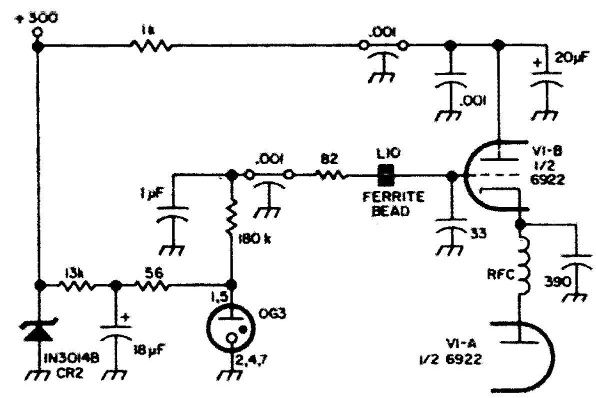
Ultra-Stable Power Supply for Master Oscillator

While performing some modifications on a commercial FM transmitter, my attention was drawn to the power supply which is used to supply dc to the master oscillator. The MO works in the 50 mhz range, but the principles of dc regulation utilized are such that they can be applied to any master-oscillator or vfo on other frequencies as well. Refer to Fig. 1.



The first regulator in the supply is a solid state zener diode, rated at 180 volts. This 180 volts is also connected to the plate of the cathode-follower tube, V1B. Note that this is a dc cathode follower. The supply voltage, further dropped to approximately 86 volts, is impressed upon the anode of the type OG3 voltage reference tube. This is an extra-stable voltage regulator tube which draws only a few mils. The high-stability 86 volts dc is impressed upon the grid of the cathode follower. The cathode is constrained to follow, and this presents an ultra-stable B-plus supply potential to the master oscillator. According to the manufacturer, RCA, the net result is a signal so steady that it can run for several hours, without benefit of AFC, and still meet FCC spec's for frequency stability in the FM band. Obviously, the MO is built of high quality parts and well designed. A frame grid tube, type 6922 is used for both the MO and the dc cathode follower. Amateurs and experimenters could use a less expensive type, such as the 12AT7, especially if the vfo is designed to operate on a somewhat lower frequency.

Neil Johnson, W2OLU

Raymond C. Sills, K2ULR
32 Ainsworth Avenue
East Brunswick, N.J. 08816

Would You Like To Be A Broadcast Engineer?

I'm sure many a ham has a little of the broadcaster in his blood. After all, both the ham and the broadcaster transmit information by means of electromagnetic radiation. Perhaps the only real difference between the two is in the intended recipient of the information: a fellow ham or the general public.

It's often said that ham radio has launched many careers in electronics, and broadcasting is no exception. In the early days of radio, there was little distinction between amateur and "commercial" operation; and the fellow who had the technical know-how to put a rig on the air for ham use could certainly put a commercial station on the air. And it's true today, too, that many broadcasting people are amateur operators, especially in the technical end of broadcasting.

I'm sure that many a Novice, having built his first rig, wonders what goes into a 50 KW broadcast rig in one of those big city stations or perhaps even his local 250 watter. There are many similarities between any one station and all the others. Obviously, each station needs an antenna system, transmitter, audio (or video) control and distribution equipment, and a place to originate the broadcasts. But apart from that, each station invariably has its own special technical needs, equipment, and facilities which are like no other station's.

It is probably safe to say that most hams in broadcasting are in the technical end of things, although there are a few well-known entertainment personalities who have a ticket. Of those fellows who do work in the technical department, most stations give them the title of "engineer," even though they might not have a degree in electrical engineering. An engineer's duties usually consist of operating the transmitter – that is, observing the operation of the transmitter, since most of today's transmitters need little attention in day-to-day operation; and/or operating the studio equipment; and/or repair and maintenance of all the station's electronic gear; and/or clerical duties related to the technical operation of the station – ordering spare parts, new tubes, scheduling manpower, etc. I use the "and/or" because the total number of job duties will depend on the size of the station at which an engineer is employed. At stations in small markets (cities) or small stations in large markets, the engineer will do most or all of the above duties. The *Chief Engineer,* in addition to these duties, has the overall responsibility and legal obligation to the station ownership and the FCC to see that the station is operating within the terms of its license and the FCC rules and regulations. To be sure, all licensed transmitter operators (and all transmitter operators must be licensed) have the same responsibility, but it is the Chief Engineer at whom the FCC and the station management will glare if there are any technical irregularities.

Job duties are often highly specialized at

the "large city" stations and network operations. Very often, a man will specialize in one small area in the broadcast technical field. For example, he might be a maintenance man, in charge of only one type of equipment, such as a particular model of tape recorder. But since large stations have many of those tape machines, he is usually quite busy just keeping them all running properly with routine maintenance: lubrication, cleaning, checking tubes, alignment, and so forth. Some of the fellows who do this specialized maintenance are so proficient and familiar with their tape machines that they can diagnose and repair a fault in 10 minutes which would take the average engineer two hours to fix.

At one of these large stations, an engineer – or technician, as he is sometimes more accurately called, – is almost invariably a member of one of the major broadcast engineer's unions: IBEW, NABET, or IATSE. As such, he is collectively bound to a contract with his employer, and this contract spells out, quite precisely, what his duties shall be.

As you might expect, some fellows (and gals, too) show a preference or an aptitude for one or more of the various specialties in the broadcast technical field. One chap might be a great studio console operator; another, a great tape editor; a third might be a transmitter expert; and yet another might enjoy working in the maintenance shop. And, of course, some people are quite competent in more than just one specialty.

If you're still all hot about becoming a broadcasting engineer, plan to make a visit to a station, TV or radio, whichever is available or preferable, and talk to some of the boys. Almost all of the fellows in the broadcast business would be glad to show you around and answer your questions. Most probably, you'll be told that you should get your commercial radiotelephone operators license.

There are three grades of licenses: First Class, Second Class and Third Class, from top to bottom, and a total of five exam "elements" that you must pass for a FCC ticket. If you can pass elements 1 and 2, you are qualified to receive a third class license. If, after passing elements 1 and 2, you pass element 3, you get the Second Class ticket. Finally, when you pass the fourth element, you get the First Class License. You could, if you like, take all four elements in the same day, but most people prefer to "come up through the ranks" and get all of the licenses, or at least the Second Class and then the First Class. The First Class License is very much like what the General Class ham license used to be: you get all operating privileges for all types of radiotelephone (no CW) and TV stations in the commercial field: broadcast, police, taxi, government, microwave relay, etc. This is the license that all Chief Engineers must have, and the one that most regular engineers have. It is a very, very valuable asset to have if you intend to get a job in the broadcast technical field (or announcing and DeeJay work, for that matter.) Without it, you cannot legally tune up *any* broadcast transmitter or operate certain classes of broadcast stations: TV, AM stations with directional antenna or stations running more than 10 KW. The Second Class allows you to service and tune up CB and two-way communications gear (police, taxi, etc. rigs) and the Third Class lets you only operate two-way gear and marine radiotelephone equipment. There is a provision of the rules that allows second and third class men to operate certain types of broadcast stations: those running less than 10 KW with a non-directional antenna. The operation is limited to turning the carrier on and off at the beginning and end of the broadcast day or for EBS tests, and adjusting the power by means of a simple control to compensate for changes in line voltage, loading, etc., that might put the transmitter more than the legal limits of 10% below or 5% above the licensed power. If a third class man works at a station, he must pass an additional exam element: element No. 9, which deals with simple routine tasks at a station, such as taking meter readings, keeping logs, frequency and power tolerances, etc.

If you are pretty good at theory, you can probably train yourself to pass the FCC test. Also, you might enlist the aid of a friend who is also studying for a commercial license. Here, the use of a license manual will no doubt be very helpful. Otherwise, it might be worthwhile to investigate one of the resident or correspondence schools that specialize in training people to pass FCC exams. As I recall, there are even some schools that guarantee you a ticket – they'll keep training you at no additional cost until you pass, should you not make it on the first try.

Once you have a license, or are at least well on your way toward getting it, get to know someone who works at a station.

Don't bug him by constantly calling or visiting him. If you use good judgment and don't overdo it, chances are he'll be more than glad to help you along with the license test or getting a job. There's usually a fairly good grapevine between stations in any one area, and when a job opens up, the word usually travels along to other nearby stations. Also, quite a few of the small local stations will train young fellows by hiring them on a part-time basis at a very nominal wage. In the large cities, inexperienced men *with a license* can often find work as summer vacation relief engineers. If they catch on quickly to how things are done at that particular station, chances are the station will ask them to return the next year. This is an excellent opportunity for a college fellow to earn extra money during the summer.

I can't emphasize too strongly this bit about having a license. It is true that many broadcast engineers in the large cities do not have a license. But you are worth much more to an employer if you have a ticket: you can legally operate transmitting equipment and this allows him greater flexibility in assigning you your duties. Also, a license is proof to an employer that you do know something about electronics.

Another training possibility is to offer your services gratis to an educational non-commercial FM station. These stations often operate on very limited budgets and can use all the help they can get for free. See if there are any college FM stations in your area. (Hint: if you have *any* FM stations in your area that operate below 92.0 mhz, they are non-commercial by FCC definition. There are, however, a few "listener sponsored" stations that operate in the commercial band, 92.0 to 108.0 mhz.)

Money

Pay is often not as much as you might expect for a "show biz" industry – probably on the order of five to six thousand dollars annually at the average station. For a beginner with something less than a first class ticket, remuneration will be $1.25 to $2.50 per hour at a small or medium-sized station. At large metropolitan stations where there is a union involved, you can expect salaries in the $200 to $300 per week bracket, with overtime pay, night-time differential pay, penalty payments for missed meal periods, and "short turn-around" (less than 12 hours between shifts) compensation. The big companies, like ABC, CBS and NBC, etc., have elaborate employee benefit programs in the form of insurance, hospitalization, pensions, stock purchase plans, liberal vacations, and so on.

So it's not surprising that many people would like to get to work for the "big" companies, since that's where the money and the action is. There is a reasonable chance that you can land a job at one of the big city outfits if you have some experience, good recommendations, and perhaps some formal training. The large companies have large manpower needs and lose a few men every year through retirement and job-hopping. The need for manpower is being reduced somewhat these days by the increasing use of automation and automated devices to control programs, perform switching, operate transmitters, and so forth. And today's solid-state gear doesn't break down as often as its vacuum tube predecessors. Also, programming – at least radio programming – is not as elaborate as it was in years past: deejays, talk, news, sports, etc. are now the rule, instead of the soap operas and variety shows which now fill our TV channels.

Good luck on the test, and welcome to the club, OM.

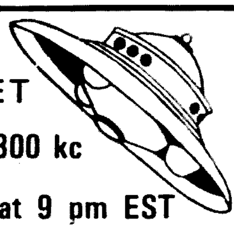
. . . K2ULR

Footnotes:

IATSE: International Alliance of Theatrical Stage Employees, 1270 Avenue of the Americas, New York, N.Y. 10019.

NABET: National Association of Broadcast Employees and Technicians, 135 West 50th Street, New York, N.Y. 10019.

IBEW: International Brotherhood of Electrical Workers, Local 1212, 150 Fifth Avenue, New York, N.Y. 10014.



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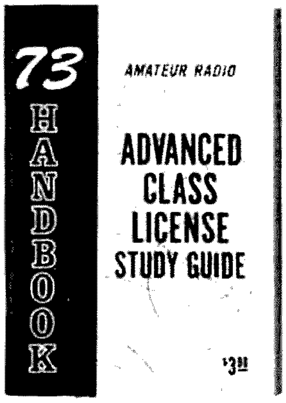

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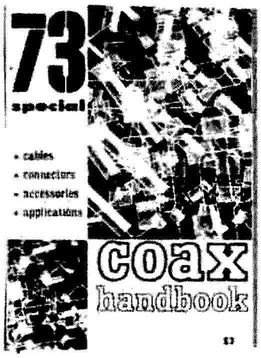

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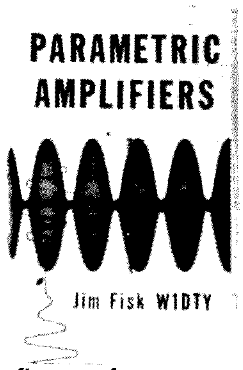

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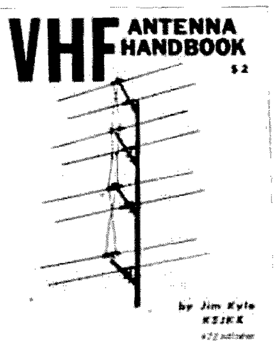

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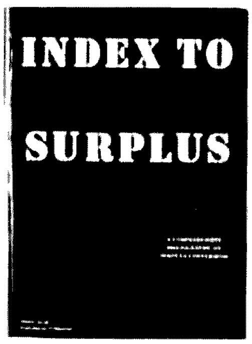

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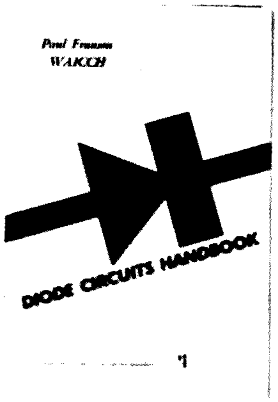

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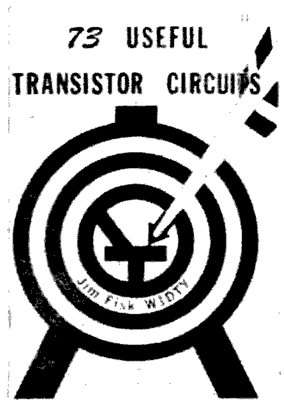

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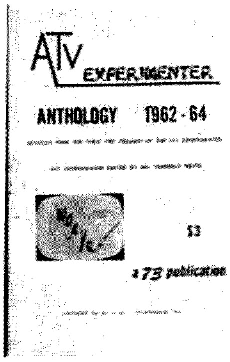

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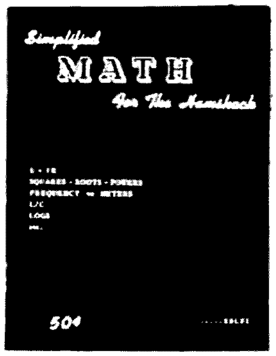

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73 Magazine

Peterborough, N. H. 03458

Distress: The Amateur Operator and the Coast Guard

John E. Fail, U.S. Coast Guard WB6UKX
P. O. Box 193
Walnut, California 91789

Official U. S. Coast Guard Photo.

U.S. Coast Guard Cutter Cape Higgon is a 95-foot all-steel cutter capable of 21 knots speed. The cutter carries a crew of 14 and the primary mission is SAR and law enforcement. The author served in this vessel in 1966, 1967, and part of 1968 as the ship's Executive Officer.

At one time or another every ham will probably handle, directly or indirectly, some type of distress traffic relating to an emergency on the high seas.

This article will delve into the maritime distress, how to handle it, what information to get, who to call with the information and how to call. The first thing that enters the average person's mind when he hears or observes a maritime emergency is *"call the Coast Guard."* One mission, by law, of the Coast Guard is to render aid to persons and property in distress on navigable waters of the U. S. and on the high seas. The Coast Guard is ready, willing, and able to accept information and coordinate the efforts needed to effect a successful rescue mission. Many persons are under the false impression that when they call the Coast Guard and pass the barest of information, the Coast Guard can pinpoint and evaluate the situation in a matter of seconds. Sometimes this is true, but not very often. Accurate and complete information must be passed to the Coast Guard.

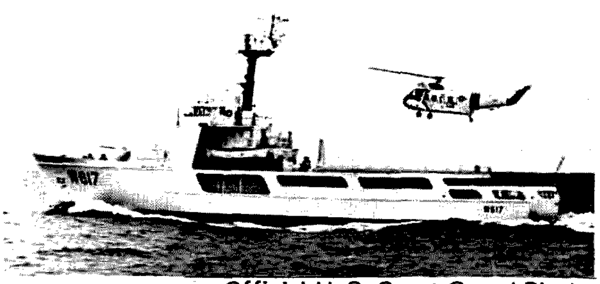
The Coast Guard is broken down into 12 Districts (**Fig. 1**) in the United States and includes many other parts of the world. Each District is assigned vessels ranging from 378-foot high endurance cutters to 30-foot utility boats. The major components of most Coast Guard Districts are its SAR (Search and Rescue) vessels. These types of boats and vessels, mostly 30- and 40-foot utility boats, 44-foot motor life boats, 82- and 95-foot patrol boats and 210-foot vessels, are the primary SAR tools of each district. These, of course, are backed up by aircraft, both fixed wing and helicopters. Most districts have vessels and aircraft that are particularly suited to their area.

The Coast Guard in recent years has

embarked on a large shipbuilding program with many SAR vessels being constructed. Of the several class vessels being built, one of the most notable is the 210-foot medium endurance cutter. These vessels are capable of operations with a helicopter and have many innovations found in only the most modern of ships in the world today.

Search and Rescue vessels are strategically placed in the Coast Guard districts so that they are within the major boating population areas as well as being readily available for long range SAR operations. Each of the SAR vessels is controlled by the District Rescue Coordination Center (RCC). Each district has its own RCC and supporting radio stations. The geographical limits of each Coast Guard District is outlined in Fig. 1. This map shows the headquarters of each district at which the RCC is located.

We have covered very lightly the basics of a Coast Guard District SAR force. Now let's go into the RCC and find out just how it operates, and enlighten this dark area for the Amateur who will probably never see one of these busy centers of activity. I am assigned to the RCC in Long Beach, California, as an assistant controller. I have also been assigned to the RCC in Honolulu, Hawaii. All watches are stood by at least two people; a commissioned officer is the controller, and a senior enlisted man is the assistant controller. All RCCs in the Coast Guard are manned and ready to serve 24 hours a day, 365 days a year. The RCC is the control point for all rescues within the assigned area of responsibility. Included with this article is a picture of the RCC in the Eleventh Coast Guard District. The caption on the picture explains the major functions of the RCC. There are, of course, many other parts of the RCC not shown in the picture; plotting tables, communications center, etc.



Official U. S. Coast Guard Photo.

The Vigilant, one of the new 210 foot cutters mentioned in the article, is shown here operating with a coast guard helicopter. The Vigilant is capable of 20 knots speed, is all steel construction, and carries the latest electronic equipment available.

PROPAGATION CHART

J. H. Nelson

August 1969

SUN	MON	TUES	WED	THUR	FRI	SAT
					1	2
3	4	$\boxed{5}$	6	7	8	9
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31						

Legend: Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7	7	7	7	14	14	14	14	14
ARGENTINA	21	21	14	14	14	7A	14	21	21	21	21	21A
AUSTRALIA	14A	14	14	14	7B	7B	7B	14	7B	7B	14	14
CANAL ZONE	21	14	14	14	7	7	14	14	14	21	21	21
ENGLAND	14	7A	7	7	7	14	14	14	14	14	14	14
HAWAII	14	14	14	7B	7B	7	7	14	14	14	14	14
INDIA	14	14	7B	7B	7B	7B	14	14	14	14	14	14
JAPAN	14	14	14	7B	7B	7B	14B	14	14	14	14	14
MEXICO	14	14	14	7	7	7	7A	14	14	14	14	14A
PHILIPPINES	14	14	7A	7B	7B	7B	7B	14	14	14	14	14
PUERTO RICO	14	14	14	7	7	7	14	14	14	14	14	14
SOUTH AFRICA	14	7B	7	14	14	21	21	21	21	21	21	21
U. S. S. R.	14	7	7	7	7	14	14	14	14	14	14	14
WEST COAST	14A	14A	14	7	7	7	7	14	14	14	14	14A

CENTRAL UNITED STATES TO:

ALASKA	14	14	14	14	7	7	7	7A	14	14	14	14
ARGENTINA	21	21	14	14	14	7	14	14	21	21	21	21A
AUSTRALIA	21	21	14	14	14	7B	7B	14	7B	7B	14	14
CANAL ZONE	21A	14	14	14	7A	7	14	14	21	21	21A	21A
ENGLAND	14	7A	7	7	7	7B	14	14	14	14	14	14
HAWAII	21	21	14	14	14	7	7	14	14	14	14A	21
INDIA	14	14	14	7B	7B	7B	7B	14	14	14	14	14
JAPAN	14	14	14	14	7B	7	7	14	14	14	14	14
MEXICO	14	14	14	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	14	7B	7B	7B	14	14	14	14	14
PUERTO RICO	21	14	14	7A	7	7	14	14	14	14A	14A	21
SOUTH AFRICA	14	7B	7	7B	7B	7B	14	14	14	14A	14A	14
U. S. S. R.	14	7B	7	7	7	7	7B	14	14	14	14	14

WESTERN UNITED STATES TO:

ALASKA	14	14	14	7A	7	7	7	7	7A	14	14	14
ARGENTINA	21	21	14	14	14	7	7A	14	21	21	21	21A
AUSTRALIA	21	21A	21	21	14	14	14	7A	7B	7B	14A	21
CANAL ZONE	21	14	14	14	7A	7	7	14	14	21	21	21
ENGLAND	14	7A	7B	7	7	7B	7B	14	14	14	14	14
HAWAII	21A	21A	21A	14	14	14	14	14	14	21	21	21
INDIA	14	14	14	14	7B	7B	7B	14	14	14	14	14
JAPAN	14	14	14	14	14	7	7	14	14	14	14	14
MEXICO	14	14	14	7	7	7	7	14	14	14	14	14A
PHILIPPINES	14	14	14	14	14	7B	7B	14	14	14	14	14
PUERTO RICO	21	14	14	14	7	7	7	14	14	14	21	21
SOUTH AFRICA	14	7B	7	7B	7B	7B	7B	14	14	14	14	14
U. S. S. R.	14	7B	7B	7	7	7	7B	14	14	14	14	14
EAST COAST	14A	14A	14	7	7	7	7	14	14	14	14	14A

A - Next higher frequency may be useful this period
B - Difficult circuit this period

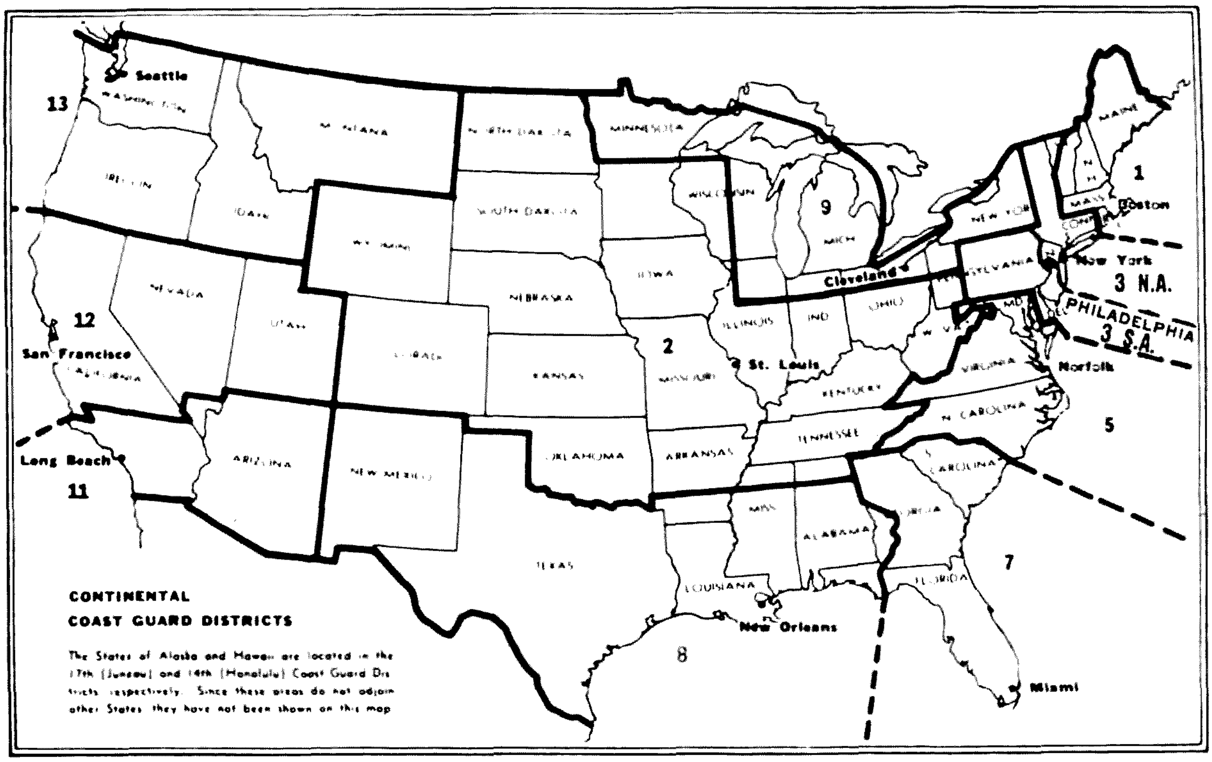


Fig. 1. Chartlet of the geographic limits of each of the 12 Coast Guard districts. The limits of each district is shown in heavy lines; the headquarters of each district is shown in heavy lettering. All of the cities on the chartlet have an RCC in them.

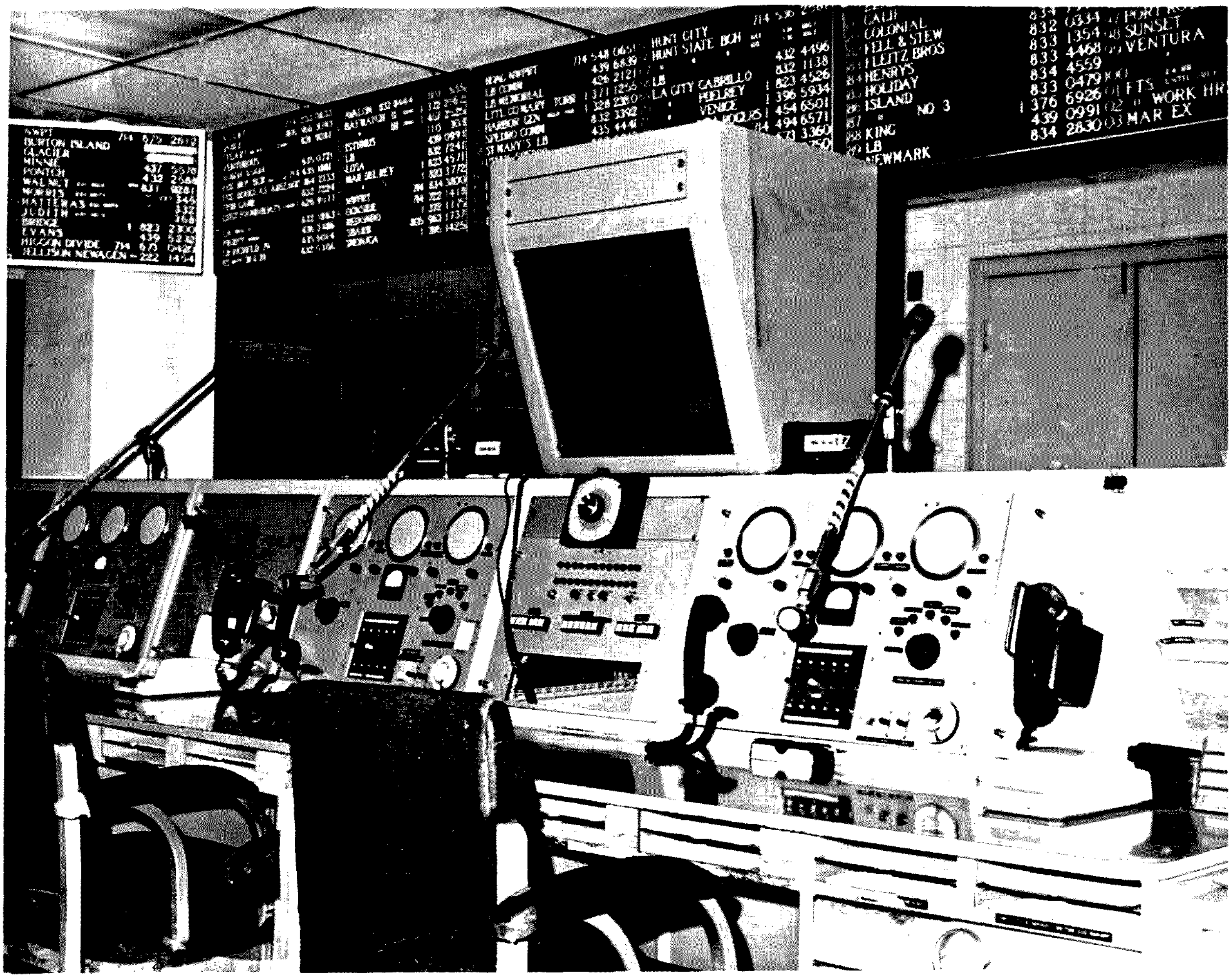
How does the Amateur contact his local Coast Guard? In all large population areas the number of the local RCC is listed in the front of your local telephone directory under "Air and Sea Emergencies" or "U. S. Coast Guard, Search and Rescue." Of course, if you live in Denver, Colorado, you had better forget it, since there is not much water for us to sail on there. An RCC would not normally be maintained in such an area, but frequently the Coast Guard will maintain small units such as Recruiting Stations, Boarding Teams, etc. in such a large population area. If your telephone book has no listing for an RCC in the front, look in the classified section under United States Government, Department of Transportation, Coast Guard. This will give the phone number of your nearest Coast Guard unit.

Any RCC will accept long distance phone calls from Amateurs concerning distress cases. In some instances the number listed will terminate at a switchboard in the Headquarters of the District Office you are calling. In this case all that is required is to ask for the RCC. Many foreign governments also maintain RCCs in their respective countries doing essentially the same job that is being done by your Coast Guard.

While you are casually tuning around,

looking for some DX, you happen across the signal of WB1ZZZ/Maritime Mobile in his 25-foot cabin cruiser, frantically calling "MAYDAY" on 20 meters. You answer him and he says he is sinking fast. What do you do? The first and most important thing is to get the vessel's position! Give the Coast Guard a place to go! If the water comes up five seconds later and shorts out his gear, we are at least armed with a position to go to and conduct search and rescue operations. We are not left in the "outfield" with nothing but the knowledge that somewhere someone is sinking. Any position given the Coast Guard should be given in latitude and longitude or range and bearing from a prominent object. Example: 250 degrees magnetic 10 miles from Long Beach lighthouse, or 40° N, 120° 10' W. Avoid positions such as "about 1 hour south of Catalina Island." Such positions are confusing in most instances, since many vessels travel at different speeds and would travel different distances in one hour, causing the position reported to possibly be in great error. This error in position could be greatly magnified if a guess had to be made as to the speed of the vessel in distress. The time saved in getting an aircraft or surface unit to the scene of such a distress could very likely save a life.

The second most important item in SAR is to maintain communications. Don't take the information and then sign off with the distressed station. Even in the most routine of cases, this could be disastrous. Maintain



Official U. S. Coast Guard Photo.

This is a view of the main console of the RCC here in Long Beach. Included is a complete telephone switchboard, vhf, hf communications system. The console can accomodate three persons operating it at one time. Hot lines are maintained to many Coast Guard units and Civil agencies, FAA etc. On top of the console our new data display system can be seen. This is a fairly new innovation in the Coast Guard. A slide projector is installed in the lower part of the console and via a system of mirrors a projection can be displayed on the screen of local boating areas, a specific harbor, or geographic area. The projector is capable of up to 80 different projections on each slide tray. The desired projection is obtained within 4 seconds of selection.

communications with the distress unit until a Coast Guard unit arrives on the scene or the distressed vessel has communications with a Coast Guard unit and you are released by the Coast Guard and/or the distressed unit. FCC regulations clearly states that distress traffic takes priority over all other communications.

Third comes the miscellaneous information, but of course this is still very important and should be obtained in every case possible. These are items such as the length of the vessel, hull color, trim color, type of vessel, name of the vessel, registration numbers, number of persons aboard, nature of difficulty, radio frequencies available, call sign of the vessel, etc.

Medical cases take on a different light, but all of the aforementioned information still applies, as it is still basic information that is required in all cases.

In a medical case it is important to contact a doctor as soon as possible. This can be done via the Coast Guard. The RCC works with the United States Public Health Service in providing medical advice to vessels with medicos (medical case) on board. In many cases the doctor will advise that an evacuation is necessary. This will normally be carried out by the Coast Guard or arranged for by the Coast Guard. The most important items required in a medico case are complete symptoms of the patient's ailment (description of injury, pulse, temperature, respiration), age, sex, name, treatment already provided and what first aid materials and medicine are aboard the vessel. Any medical history connected with the symptoms that the patient is experiencing, next of kin, address of next of kin, nationality of the patient, and of course, once again, the position of the vessel. This has a great bearing on the case to the Coast Guard, especially if an evacuation is recommended by the doctor handling the case.

When calling an RCC to pass distress information, always give your name, telephone number, and call sign so that credit will be given where it is due. The RCC may also want to contact you again to get further information or clarify the original information.

In many cases the Amateur has a phone patch in his station. In this case the RCC Controller may prefer to be phone patched directly to the distressed vessel. This, of course, eliminates the middle man and assistance is dispatched all the sooner to the assistance of the vessel.

This is especially true of the medical cases where the Coast Guard may not always have firm communications with the vessel. The RCC may ask you to call the doctor so that you may phone-patch the doctor directly to the vessel to provide medical advice.

The Amateur radio operator is and can be a most important and useful tool in the complex machinery of the SAR business, but only if he has obtained complete and accurate information. Double check important items: position, nature of difficulty, size and description of the vessel.

Since being assigned to RCCs, I have in many cases worked directly with Amateurs concerning distresses. Recently, an Amateur in Santa Maria, California, obtained information via 20 meters concerning a heart attack victim aboard a ship several hundred miles off the Southern California coast. He called the U. S. Public Health Service doctor in San Pedro, California, and passed all the medical information to the doctor. The doctor called the Coast Guard RCC in Long Beach, California, where, incidentally, I was on watch. He requested that the Coast Guard provide an evacuation for the patient. The Amateur involved in this case had very complete and accurate information. So, without a doubt, the timely and quick action of this Amateur led to a successful evacuation of the patient. After the doctor's call to the RCC, we contacted the Amateur directly and obtained further information on the position, type of vessel, etc. The RCC passed the position information to the AMVER (Automated Merchant Vessel Reporting System) center in New York and requested a SURPIC (surface picture) for vessels in the area with doctors on board. Within minutes a SURPIC was received from the AMVER center. I provided the position of several ships in the area of the vessel with a doctor on board. Within five hours of the receipt time of the first information on this medico, the patient was aboard a large passenger ship with a doctor on board and on his way to a hospital in San Francisco. The Amateur who so capably handled this case was W6ELH. The speed with which this mission was carried out contributed greatly to the saving of the life of the seaman involved.

I mentioned the AMVER system. This system consists of a computer located at the

Coast Guard Base in New York. Many merchant vessels participate in the AMVER program by providing SAR capability information, as well as voyage information, course, speed, etc., which is fed into the computer and is stored until the vessel's voyage is completed. Any RCC can ask the computer at any time for information on ships which may be in the area of a distress. The computer will reply with information (SURPIC) on these vessels via teletype within minutes. The AMVER system could be the subject of a complete article in itself. It suffices to say here that the computer can provide immediate information on many merchant vessels in a large portion of the world.

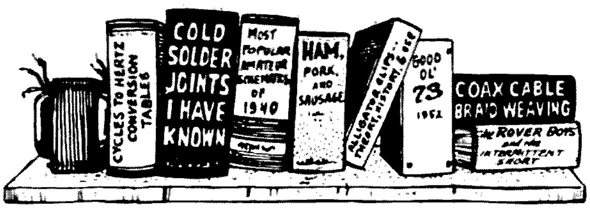
The Coast Guard is willing and eager to establish a good working relationship with any and all Amateurs, who are a group that is most valuable and possesses the potential to be a vital link in distress communications.

The Coast Guard knows what kind of information it needs to handle emergency cases of almost any type, but this is only one side of it. The other side of the successful carrying out of a rescue mission is *you,* the Amateur; you must provide accurate information, get the position, provide communications and maintain those communications.

Distress traffic can easily excite a person to the point where he makes many mistakes, this can lead to tragedy. If there is a nervous tone of excitement in your voice when working the distressed unit, it could upset the persons aboard the distressed unit and lead to disastrous consequences. Keep your head, speak normally and reassuringly, double check all information, and assure the distressed unit that assistance is being summoned. Tell the vessel that help is on the way when you are so informed by the Coast Guard. The vessel should be told what kind of unit is coming to their assistance. The Coast Guard will provide you with this information, as well as an estimated time that the Coast Guard unit will arrive on the scene.

I hope that this information will be of benefit to Amateurs and others as well. Any questions or comments concerning the various aspects of SAR are most welcome. You may write to me at my mailing address; any and all inquiries will be answered. Review all the information in this article, use the forms, study the procedures, and you and your station, as well as the United States Coast Guard, will be *"semper paratus."*

. . . WB6UKX



NEW BOOKS

KNOW YOUR VOM–VTVM, 2nd Edition

This authoritative text explains volt-ohm-milliammeters, vacuum-tube-voltmeters, and solid-state electronic voltmeters of the types of circuits used. In addition, the text explains uses, care, and repair of the instruments. Basic concepts are thoroughly presented to help provide for an understanding of electrical measurements. Questions at the end of each chapter help to reinforce learning progress. $3.50 from Howard Sams.

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Explains the principles and uses of RTL (Resistor-Transistor-Logic) digital integrated circuits. Provides the experimenter with an understanding of RTL in integrated circuits as they are used in everyday electronic projects. Shows the technician how these circuits work and how they are maintained. Provides the engineer with convenient form circuits that can be easily adapted as building blocks in larger systems. $5.25 by Sams.

F. Dale Williams, K3PUR
HRB-Singer, Inc.
Box 60 Science Park
State College, Pennsylvania 16801

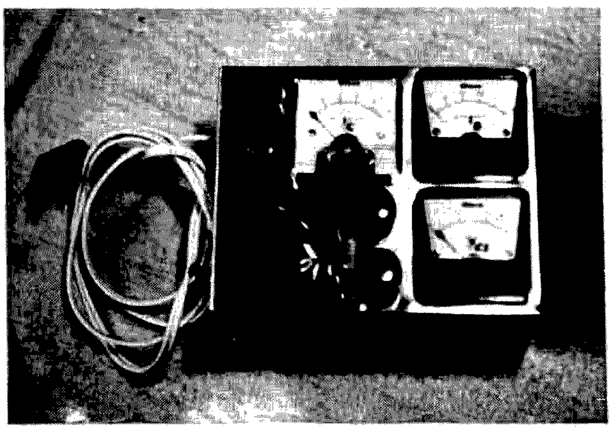
A Transistor Parameter Tracer

At the author's overseas QTH there are presently three projects under design and construction, all utilizing transistors. In the usual cigar box search for components, fifteen transistors of different types were found. However, a subsequent look through the reference file showed specification sheets for thirteen of the fifteen transistors, but only one with dc biasing curves.

Most manufacturers include on their spec sheets such data as maximum allowable voltage measured from collector to emitter (VCE), maximum allowable collector current (IC), maximum voltage collector to base (VCB) or base to emitter (VBE), maximum power dissipation at 25° Centigrade (PD) with derating factor for other operating temperatures, and typical beta (hfe) or forward current transfer ratio measured at a given set of parameters. This amounts to the minimum amount of data necessary for basic design purposes, but once the transistor is purchased and a circuit must be constructed, a number of problems suddenly arise. For instance, if the specifications for a gain of 100 are given as VCE = 5 V, IC = 1 ma, f = 1 khz, what change in the value of beta can be expected when VCE = 12 V, IC = 2 ma, and f = 7mhz? Just as important is the missing value of base current (IB). Since the transistor is a current amplifying device this parameter is as important for optimum gain as the grid bias in voltage amplifying tube circuitry.

The test unit to be described here is essentially a variable dc transistor power supply with three meters which allow the parameters VCE, IC, and IB to be monitored simultaneously. Thus, the designer may vary one or more dc parameters and, by plotting the resulting values on linear graph paper, have a permanent record of the dc curves for each individual transistor. This is important, due to the fact that most transistors are produced in "batch" quantities and no two of the same type have exactly the same parameters. In addition, the value of beta at different bias points may be computed by using the set of dc curves. The value of such design data should be apparent. With the dc parameter information obtained from the Transistor Tracer, circuitry can be designed and constructed without the usual trial and error method. By selecting a suitable bias point on the dc curves for the required value of beta and computing the necessary resistances by Ohm's Law, there will be no question of possible saturation, cut-off, or low gain. An additional feature of the Transistor Parameter Tracer is its ability to be utilized as a power supply with variable voltage control and a safe output of 12 V at 400 ma or 15 V at 300 ma.

The unit shown in the photographs was constructed using a Bud 5 x 4 x 3 inch Minibox. As can be seen, no extra panel



Overall view of completed Transistor Parameter Tracer.

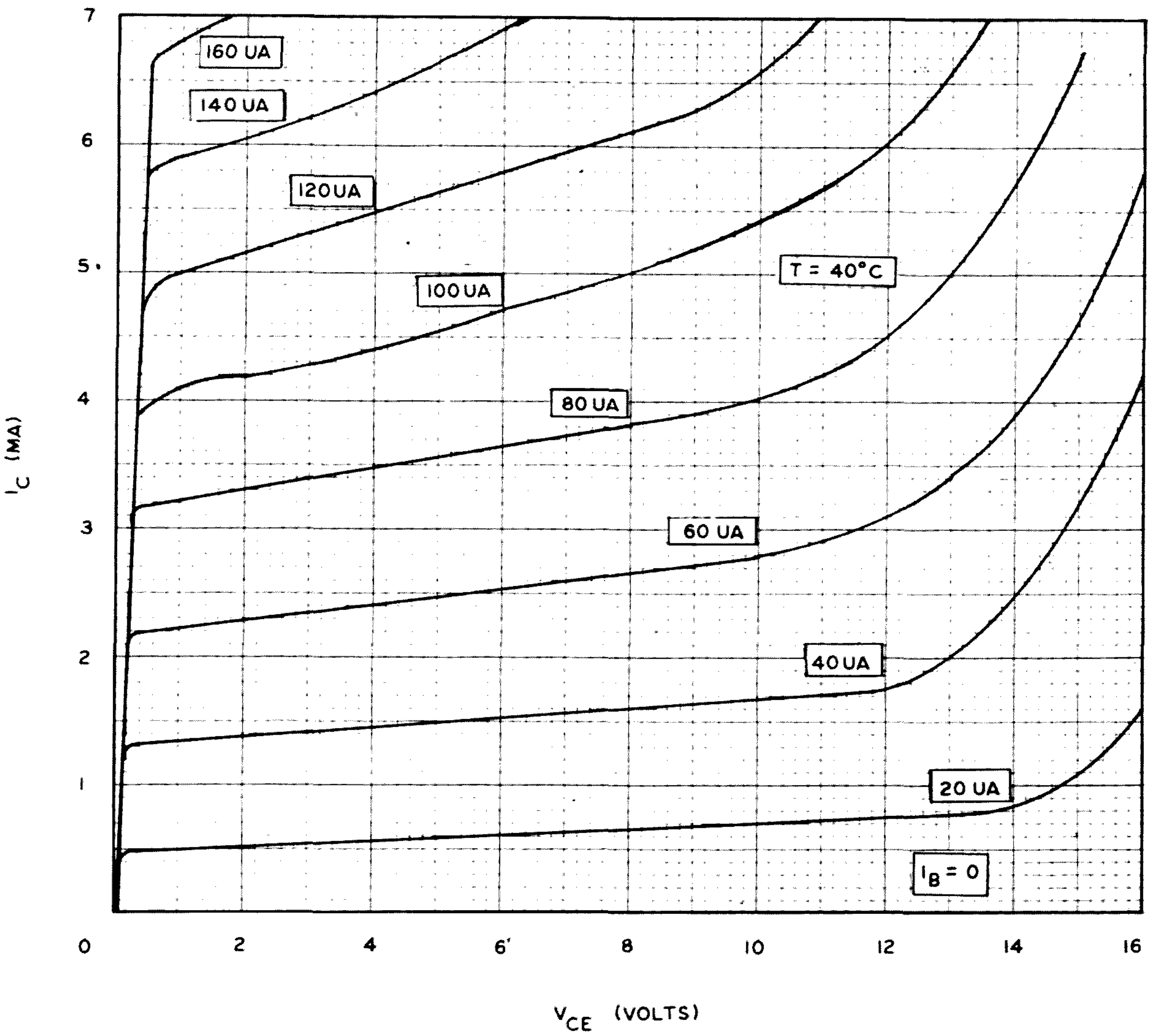


Fig. 1. DC curves of 2N918 transistor obtained with the Transistor Parameter Tracer.

space is available and the SPST power switch is mounted on the left side of the box. The size of the meters used determines the space left for the controls when using standard-size miniboxes. The author sacrificed greater accuracy for economy and space by utilizing Japanese meters. The 0-15 Vdc meter is model ME-102, 0-50 ma model ME-98, and

$$\text{beta} = \frac{I_C\,(\text{uA})}{I_B\,(\text{uA})}; \quad V_{CE} = 12\text{ V}$$

I_C	I_B	beta
1.4 mA	20 uA	70
2.3 mA	40 uA	58
3.5 mA	60 uA	58
4.8 mA	80 uA	60
5.8 mA	100 uA	58
7.2 mA	120 uA	60

Table 1 - Values of beta taken from Fig. 1.

0-500 ua model ME-101, all available from Olsen Electronics, Inc., 260 S. Forge Street, Akron, Ohio 44308, at a total cost of $8.65.

Pre-installation testing of these meters showed two to be inoperative. The armature had to be loosened by resetting the tension screw on one, and a loop of the moving coil had to be removed from its inadvertent position under one of the cross arms of the pointer on the other, before normal operation was obtained.

For greater accuracy and reliability, other meters, such as those produced by Evans Radio, Inc., may be used. The neon pilot light was obtained from Olson, order number KB-164, and is supplied with dropping resistor (3 for 99 cents). The transformer shown is a 117/12.6 V at 1 A unit from Olson, order number T-304, for $1.49. Each diode in the bridge network must have a minimum current rating of 350 ma. The silicon rectifiers used by the author were

500 ma units purchased from Olson, order number RE-70, four for 99 cents.

The transformer is mounted on the right side of the minibox with the wires toward the center of the top panel, and just high enough to allow clearance for the bottom of the box. The four diodes, 2-watt resistors, and pilot light dropping resistor are mounted on a piece of Vectorboard which is attached to the top of the transformer frame with epoxy glue. Not much space is needed for mounting these components, but overall board dimensions will be determined by the depth of the meters.

Due to the change in parameters which occurs when a transistor is subjected to temperature variation, the transistor socket should be mounted on the opposite side of the box from the transformer. A number of holes, ¼ inch in diameter, should be drilled above the transformer on the side of the minibox and on both sides of the other section of the enclosure, just below the transformer, to allow air circulation. In cases where the transformer produces excess heat, it will be necessary to place a heat shield around the socket. The first filter capacitor is soldered across the bridge and is supported by its own leads. Two electrolytics are not necessary, but the added filter capacity is desirable. The 25 k ohm control is a 5-watt miniature unit made by Mallory, model number VW25K. It is smaller in size than the average potentiometer, but well within its power rating. Unfortunately, it was not tested before installation and subsequent trials of the completed tester showed no voltage or current on the meters while adjusting the 25 k ohm control through its middle range. Removal of the rheostat cover exposed the outer contacts which are dependent upon the pressure from an insulated metal spring plate attached to the cover to depress the clamped metal ends of

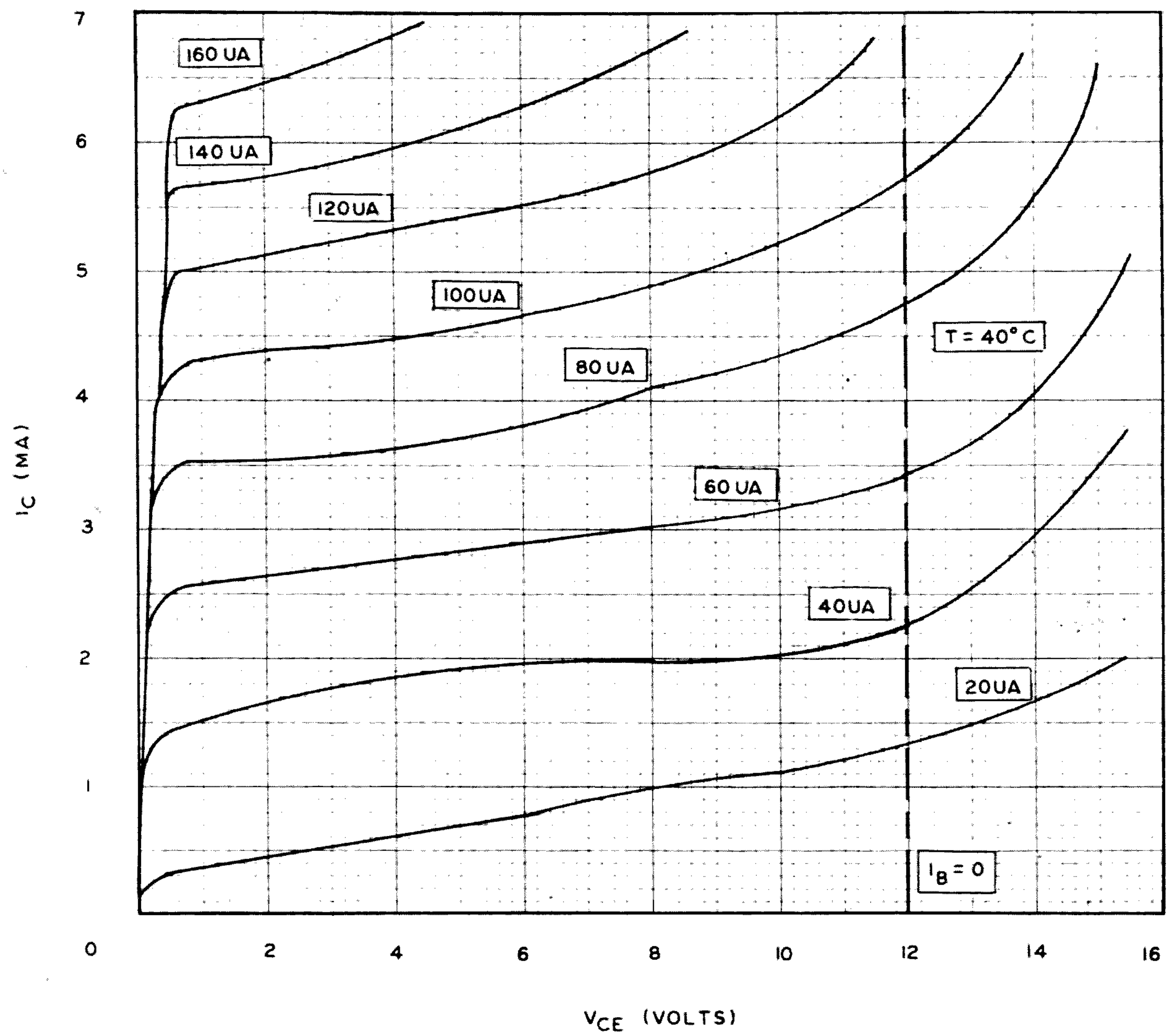
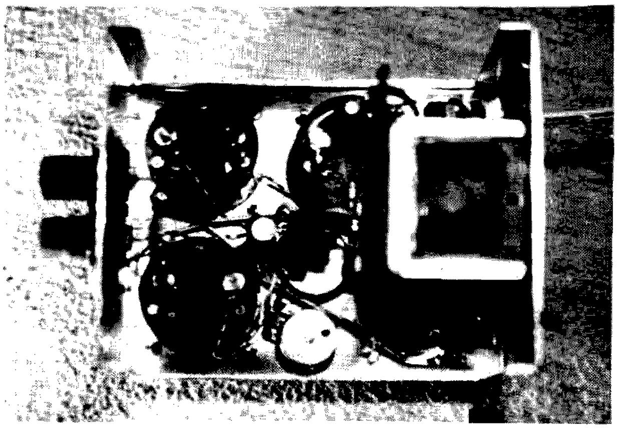


Fig. 2. DC curves of 2N918 transistor from manufacturer's specification sheet.



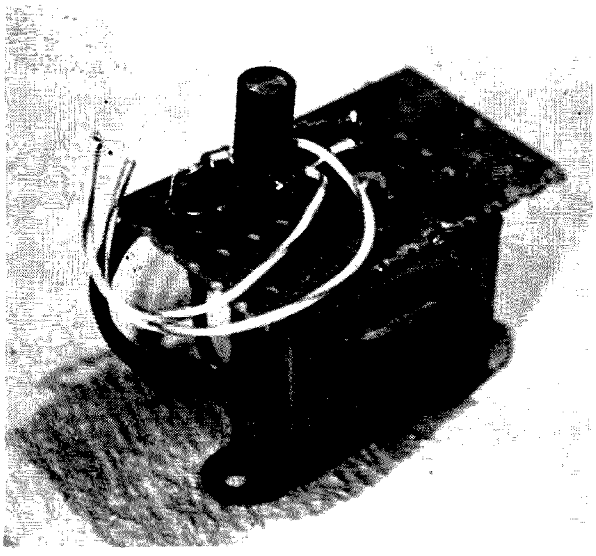
Inside view showing placement of components. (Output terminals and transformer should be switched to alleviate heating of test socket).

the wiper arm field to each terminal. The inside ends of the two outside terminals were bent up, as were the ends of the spring plate, and the cover replaced as tightly as possible to produce satisfactory operation.

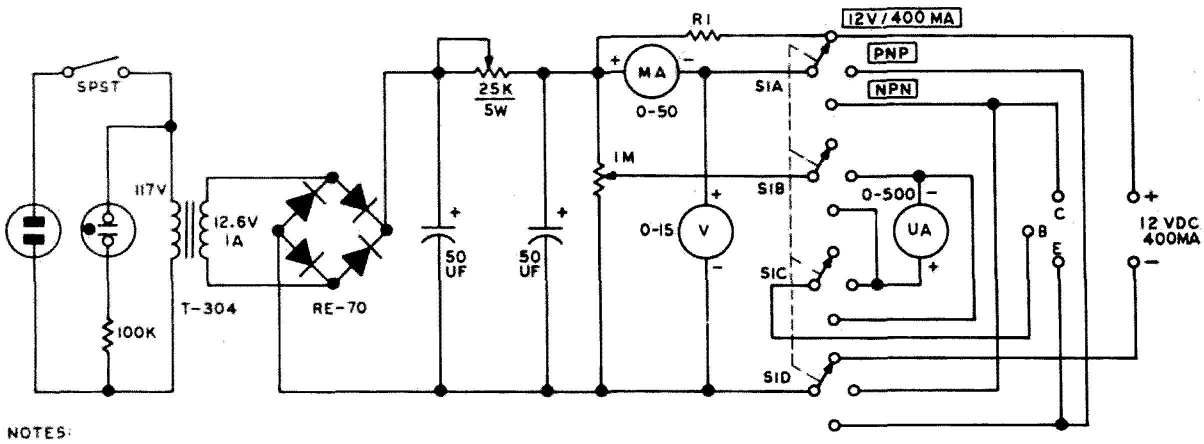
The value of the bias control is not critical, with the exception that too low a value will draw unnecessary current, requiring a larger rheostat. Also, since no series meter resistor is used, the medium setting of this control should provide meter protection in the event that the transistor under test is shorted. In order to be able to monitor voltage and current when the Transistor Parameter Tracer is utilized as a power supply, the voltmeter is connected across the circuit at all times. When the function switch is in the 12 V/400 ma position, the 0-50 ma meter is shunted with constant resistance wire (R1) of a value which allows the meter to measure 0-500 ma, or ten times its normal scale. The value of this shunt resistance is determined by the formula R = Rm/n-1, where R is the necessary shunt resistance, Rm is the internal resistance of the meter, and n is the factor by which the original scale is to be multiplied. Thus, with a meter resistance of 2 ohms, the necessary shunt resistance is R = 2/10-1 = .22 ohms. If constant resistance wire having a resistance of 2 ohms/foot were used, 2/12 = .22/length = 2.64 inches of this wire would be needed for the shunt. It is best to cut the length slightly longer to allow for soldering, then adjust by cutting about 1/8 inch at a time from the length while monitoring the output with a variable 5-watt load connected in series with a reference milliamp meter. With a variable load between 24 and 120 ohms, the meter reading from 100 to 400 ma can be checked. An alternate method, not requiring a reference meter, is the use of composition resistors, arranged in series or parallel, to give a value of 30 ohms with a power dissipation of 5 watts. With this load connected across the output, a 12 V reading on the voltmeter should give a reading of 400 ma on the milliamp meter when the shunt is the correct length. Keep in mind that the power rating of the supply is 5 watts, limited by the 25 k ohm control, and any reading over 12 V at 400 ma will be close to exceeding this value, causing possible damage to the rheostat. All meters should be calibrated with the help of a reference meter and the zero-set screws made fast with a drop of clear nail polish or glue. The output terminals to which the Transistor Parameter Tracer supplies power when the function switch is in the 12 V/400 ma position, are H. H. Smith type 269RB.

Operation

A volt-ohm meter should be used to check out wiring and to assure that the function switch has been connected with the correct polarities (NPN, PNP) in reference to the transistor socket pins. To preclude applying too high a voltage to the transistor under test and to protect the meter in case of an inner transistor short, the VCE/IC control should be set to maximum resistance before applying power. Potentiometer IB should be set at mid-range for similar reasons. In addition, since transistor breakdown from possible transients can occur when inserting a transistor into the socket with the power on, the line switch should



Power supply components are mounted on small piece of Vectorboard glued to transformer.



NOTES:
1. UNLESS OTHERWISE INDICATED RESISTANCE IS IN OHMS.
2. S1 = 4-POLE, 3-POSITION SWITCH.

Fig. 3. Schematic of the Transistor Parameter Tracer. See text for component description.

remain off until the transistor to be tested is inserted and the controls are set as above.

After setting the function switch on the polarity of the transistor to be tested, inserting the transistor into the test socket, and adjusting the controls as outlined above, power may be applied. The VCE/IC and IB controls are interactive; that is, changing the setting of one will affect the meter reading controlled by the other. Therefore, it is possible to obtain a dc curve within the limits of the meters and the transistor under test. By advancing the VCE/IC control until a reading is shown on the milliamp meter, the first set of values is obtained. Varying the IB control will show whether the base is drawing current or if it is cut off. Continual advancing of the VCE/IC control in convenient steps will give additional sets of values, as advancing the IB control will give different levels of base current. By readjusting both controls for each set of values, a constant base current curve at difference values of VCE and IC can be noted.

These values of VCE, IC, and IB for each setting can be transformed into a dc curve for the transistor under test by utilizing linear graph paper. **Fig. 1** shows such a dc curve for a 2N918 transistor, plotted from values obtained with the Transistor Parameter Tracer. **Fig. 2.** shows the dc curves included on the manufacturer's spec sheet for this transistor. The value of beta, or the gain which can be expected from the transistor under test, can be computed at any point along the dc curves. Since beta = IC(ua)/IB(ua) for any constant value of VCE, beta may be determined for any corresponding values of IC, IB along the chosen vertical VCE axis. Table 1 shows the computed values of beta taken along the VCE = 12 V axis for the 2N918 transistor. The values of beta obtained with this Transistor Parameter Tracer are valid only for the common emitter configuration. Naturally, the available gain will not be as great when the transistor is used in the common base configuration, and cannot be expected to provide any gain when utilized in the common collector configuration.

. . . K3PUR

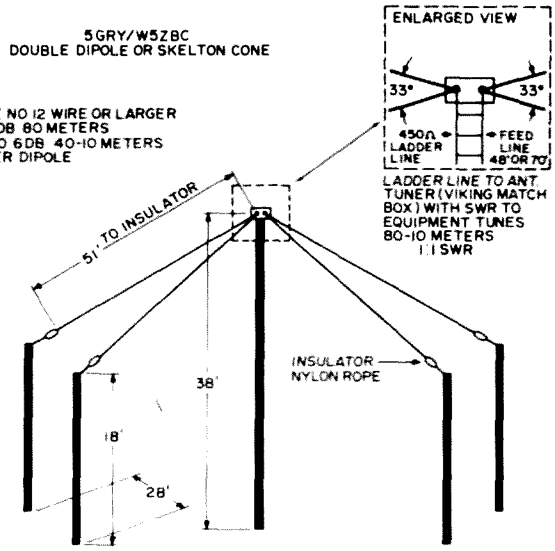
"I'd suggest you take up a nice hobby like amateur radio . . . and I just happen to have a great deal of extra equipment I can sell you cheap."

The Skelton Cone Antenna

In building, testing, trying all types of antennas for a number of years, I firmly believe the antenna to be the most important piece of equipment in the whole amateur station. In fact, by doubling power to your final you will most probably raise most ham receivers a half "s" unit. But having an antenna that will require the transmitter to be bolted down to the table, less it be drawn up into the antenna with all the other *rf*, will undoubtedly raise the "s" meter to 6db. This is exactly what The Skelton Cone Antenna will do: (1) require that your equipment be bolted down and (2) an increase of 6db on four amateur bands and 2.4db on 75 and 80 meters. If you are interested read on.

The basic idea of the Skelton Cone comes from the *RSGB Handbook* (3rd Edition, pp. 387-88) and the trial and error method of antenna construction. The Skelton Cone at this location as compared to a dipole at the same height and the same plane on the compass has provided the following:

1. 5.2 to 7 db gain on 40, 20, 15, and 10 meters over a dipole.
2. 2.1 to 4 db gain over a 75 and 80 meter dipole.
3. 1.1 SWR over 80 through 10 meters (phone and cw).
4. Provides for a double angle of radiation to provide less qsb.
5. Seems to have a pattern of 360 degrees with no reduction or increase of single in any one direction.
6. Provides for the e.m.f. of the antenna to be from 250 to 300 feet vs. 33 feet on a dipole, say on 40 meters.
7. Employs an antenna tuner to curb harmonics.
8. 3 db over a vertical in Europe or the South Pacific.



9. Creates something to talk about on the ham bands (Ref. *73* de W2NSD/ 1 Jan. 1969, p. 4)

The skelton cone also works on 3.311 kcs and 4.590 kcs, 2 different AF MARS frequency.

This antenna is well worth the low cost and will match some of the "so-called" amplifiers one hears on the air today. Whether it will provide you the gain claimed, I don't know, but there is one way to find out. Put it up and burn up the front end of your best friend's receiver. If you have questions, please forward SASE.

Eddy Shell, W5ZBC

Robert H. Grenell, ex-W8RHR
3926 Beech Street
Cincinnati, Ohio 45227

What Are We Here For?

No government has ever granted any privilege which was not demanded by the majority of the governed unless it felt that it had something to gain from so doing. Regardless of idealistic, democratic concepts, rights and privileges are not inherent, but are granted by those in power . . . or taken from them by force of revolution. If the government believes that certain privileges are no longer necessary or beneficial, it is quick to withdraw or usurp them. To those interested in the philosphical aspects of governmental power, I recommend readings from the works of Thomas Hobbes and John Stuart Mill.

How do these rather basic concepts of governmental behavior affect amateur radio? For better or for worse, they affect it very directly. The privileges accorded the Amateur Radio Service are no different from any other privileges granted by the government. The government believes that it and the country as a whole have something substantial to gain by the existence of amateur radio, and with good reason. To this self-seeking end, and no other, the government suffers the Amateur Radio Service to exist. Remember that.

Certain things are expected of us in return for our privileges, and it has now begun to look as though the time isn't far off when the government will examine the performance and contributions of the Amateur Radio Service to see if we're holding up our end of the deal. The result of that examination is entirely up to us. Whether the Amateur Radio Service will continue in its present form, be extensively curtailed, or even eliminated depends wholly upon whether the government feels it's getting what it wants and needs from our efforts.

With a TV-watching public convinced that radio amateurs constitute a marginal, if not detrimental, lunatic fringe of society, and a government which daily gobbles up more and more individual rights, where do we stand? In a world clamoring for more and more space in every dimension including the *rf* spectrum, can we justify the niche we occupy?

The trouble has already begun. Hams all over the world are aware of the plight of Ansel Gridley, W4GJO, who is being sued for $1,000,000 because of TVI which the FCC investigators stated was not his responsibility! Despite this statement exonerating Grid, a court of law entertains this absurd suit on the grounds of "electronic invasion of privacy." In all probability, Grid will win his case . . . but only at great expense in time as well as money. However, if there ever was a danger signal, this is it.

It's time to take a good look at ourselves and act on what we see. It looks like about 25% of the active amateurs are carrying the other 75% around on their backs. The moon-bouncers, the phone-patchers, the traffic nets (the ones that do something besides originating their own messages), and the emergency nets are doing most of the work of justifying our licenses!

There are those who will say that amateur radio is a hobby, not a job, and should be participated in as a hobby. But just remember that the very existence of this hobby depends on the patronage of a government which in recent years has become very acquisitive of rights and privileges. Sure, amateur radio is a hobby, but it seems that it's going to take a lot of work to guarantee its continued availability!

There are three basic jobs which must be undertaken soon if Amateur Radio's survival is to be assured: (1) We must fully exploit our public service capabilities. (2) We must fully exploit our technological ability, and advance the "state of the art" as we have in

the past. (3) We must achieve maximum exploitation of our activities in terms of public relations.

Wayne Green, W2NSD, editor and glorious leader, has thoroughly hammered home the point that what is needed for openers is an intensive public relations campaign. There simply are not enough of us to form a meaningful pressure group, and we must, therefore, rely on the public, which knows little or nothing about us except that we occasionally interfere with their TV reception. To get the public on our side and out of neutral and/or hostile corners, we must acquaint them with the things we're doing and have done in the past which have bettered the lot of the people as a whole. But most important, we've got to be sure we have plenty to tell them about . . . things we're doing now, things we've done in the past that are affecting their lives now, and how they benefit now from our activities.

They should know that without amateur pioneering in the vhf spectrum, many things taken for granted would not be possible – things like the dependable microwave links that cover the entire country with television network programming, and the similar microwave links that have made possible the continually decreasing costs of long distance telephoning; and the highly reliable communications between earth and our astronauts in space. They should know that amateurs around the world are communicating via moon-bounce, perhaps paving the way for a truly global television system, and perhaps opening still another door in the communication/cost barrier. Perhaps they should be told that the most efficient method of voice communication yet developed, single sideband, is the result of amateur development and experimentation – but that sort of thing doesn't really mean much to the public as a whole.

They should be told that in time of emergency, a trained group of communicators stands ready to render invaluable assistance. Public officials and charitable organizations should be made aware that hams stand ready to aid them in any worthwhile project or endeavor requiring rapid and sure communications. We're in the unique position of having to "sell" the services we want to give away, because too few people are aware of our potential . . . and sometimes I wonder if even we are fully aware of it. Every parade, boat race, sports car rally, door-to-door charitable solicitation, every three-day week-end, provides another opportunity for hams to demonstrate their public service potential – and get it publicized.

How about a rush-hour traffic watch? In a given city or town, every ham with a rig in his car could call in traffic and accident alerts to police and to a *cooperating radio station.* The radio station is the kicker, because every time a traffic bulletin comes through, Radio Amateurs will get a plug if the project is properly set up to begin with. Receivers could be given to the station and to the police to receive the alerts. Probably all it would take is for an organized group of hams to contact a well-rated radio station and co-ordinate the project with police. Radio stations are constantly looking for new gimmicks, and this is just as good as the overworked "copter cop" routine.

Those who enjoy home-brewing can intensify their efforts and truly advance the "state of the art." I don't care what anyone tells you about technology having outstripped amateur techniques; we're the ones who let it happen while we complacently fell asleep at the switch. You *can* make a breakthrough; you *can* develop new techniques and applications. Every month new solid state devices become available to amateurs. Use them. Experiment. Build. Do something.

We are truly responsible for our futures as radio amateurs. Sure, amateur radio is a hobby, but it's a responsibility too – at least under the present scheme of things. We can make amateur radio such a powerful tool that the entire country will be convinced of our usefulness and seek out our services. Sure, amateur radio is a hobby, but compare it with other hobbies as, for example, pleasure boating on the Ohio river. How long do you suppose that would last if it were determined that it was interfering with shipping?

We're luckier by far than most hobbyists. We have a great opportunity to justify our existence, and secure the continuation of our hobby just by performing. Let's do it.

. . . ex-W8RHR

A Thought

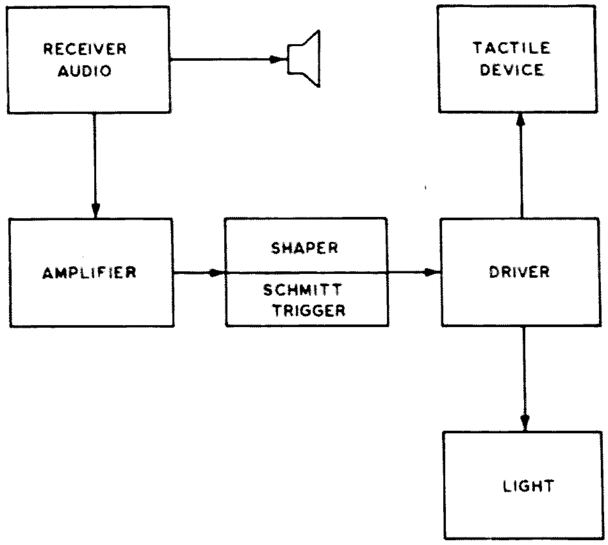
For a number of years now I have read on various occasions and in various ham magazines, articles on helps for the handicapped. A most admirable activity.

On most all occasions this took the form of apparatus, and hints and kinks for the sightless. And a few times articles for the handless and for people with mobility problems. But never have I seen materials, helps, or apparatus for the deaf or the deaf mute. I do not mean the hard of hearing (better amps, etc.), but those who have gone deaf, or those who have been deaf all of their life. I do not think this lack need exist. There are many thousands of deaf in this country. I am inclined to think that there are more deaf than blind! I'm sure that not all of them would be hams, but why not some? Wouldn't this make a fine hobby for a deaf child as well as a hearing child? And how many hams have lost their hearing and given up ham radio? I don't know, but I'm sure it need not be so.

One should consider the amount of use a ham makes of his eyes and compare this to the use he makes of his ears; what with scopes to visualize and the wave forms and meters to monitor the dc levels, what does one use ears for? Well, it's quite obvious that hearing is necessary for voice communication. But hearing is certainly not necessary for hams to communicate. There are other methods which could be used. T.V., FAX, RTTY, CW. FAX does not seem to be too popular at this time. TV is too complicated for most. But this does leave RTTY and CW. For the beginner, CW would seem the most logical, and for the advanced ham, RTTY would be a most interesting challenge.

The following circuit could be worked out and added to almost any receiver to convert the audio tones to either tactile or visual stimuli. I'm not sure how fast one could copy CW tactually or visually but, I'm sure 5 wpm would be copyable.

Suitable RTTY set ups are ubiquitous enough so that not much need be said on that matter. One must surely learn to use the eyes for all actions, but this does not seem to be an overwhelming problem. I'm not deaf, but I did try to simulate the problem by turning off all the sound in the



shack and working 6-meter RTTY. I did it with no great difficulty. I am least of all a CW type and find it hard to copy CW with all of my senses, so I could not simulate CW.

In closing let me say that I think it behooves all hams to consider all those who could enhance our hobby.

Robert D. Bailey, K3AQH

Scanning the Flyers

Radio Shack has put out a flyer in celebration of its 46th anniversary. They've made it worth your while to celebrate with them. Like, for instance, a simple receiver for the low-budget beginning amateur. Thirty-five years ago, he'd have started with a pair of UX-230 tubes in a regenerative detector plus one-stage audio. Then radio got complex and the beginner got left behind. Radio Shack has reached out a helping hand in the form of a kit, at $19.95, that is the modern solid-state version of the simple set that got many young chaps started in amateur radio. It's called Globe Patrol.

Parts, though, are the items bargain hunters search for, and Radio Shack has some at less than you'd expect to pay. A "build-it-box," perf board plus plastic cover, at 59c. Ten 14" jumper leads for 99c (most other places have gone up to $1.19). A slim 30-watt soldering iron at $1.49 which needs no stand. Two other items are not only handy things to have in the shack but can be, literally, life savers under certain circumstances. These are master controls for 117-V ac lines. One, at $3.19, controls three circuits, each with an independent switch and individual pilot light. The other, which sells for $3.99, is a master control for six circuits, all of which (including the pilot light) are controlled by a single switch. A master control like this can save your life if you should get tangled up in high voltage, and someone not too well acquainted with your shack has to locate a power switch in a matter of seconds. Having seen a friend get killed on a 117-volt line, I'm a bit touchy on this subject.

If you want to pursue the subject of multiple power outlets in greater depth, I suggest that you get Waber's 1969 catalog (Waber Electronics, Inc., 2000 North Second Street, Philadelphia, PA 10122). It shows a comprehensive line, offering such refinements as variable voltage, timed on, timed off, volt meters, circuit breakers, etc. These can make a neater as well as a safer shack.

It would seem that most wholesale houses buy their wares from the same source. It's not often you find an unusual item. . .or one at an unusual price. Olson Electronics catalog No. 369 appears to have departed from the pattern of universal similarity. I found a number of articles that were either below the customary price or different from the competive run.

For instance, there's a "wired wireless" extension speaker system that would seem to have almost limitless application possibilities.

Have you ever been tempted to use a rocker switch in place of a toggle. . .then had second thoughts because of the difficulty of cutting a rectangular hole in a panel? Olson gives you another choice; it offers a "see-saw" switch that looks and works much like a rocker, yet mounts in a round (3/4 inch) hole like a toggle. These cost 99¢ each.

There are many mini-multi meters. (How's that for alliteration?) on the market at very reasonable prices. Most of these, though, have voltage ranges that limit their use with amateur transmitters, where voltages above 1000 are often found. Here, again, Olson breaks the usual pattern. Their 20,000-ohms -per-volt multimeter, selling for only $7.99. has a top DC range of 2500 volts; on AC, it goes to 1000.

Tiny electrolytic capacitors compatible with small-sized transistorized circuits usually have prices inversely proportional to their size. At Olson's, you can buy 10 or 25 mfd 25-volt ¼" x ½" capacitors at five for 99¢.

From these examples, I've concluded it's worth the time to scan carefully every "flyer" that comes to hand. There are enough hidden bargains to make the practice profitable.

Carl C. Drumeller, W5JJ

LETTERS

Letters,

The article on "Adjusting FM Deviation" in the June 73 was interesting, but it does have some drawbacks. The author recommends monitoring the receiver with a scope while adjusting the transmitter deviation and watching for a flattening out of the CRT display. The trouble with this approach is that the flattening out is not necessarily an indication of the receiver band-pass limit; it could just as well be audio limiting of the deviated transmit signal.

A better approach: If the system contains both wide and narrowband units, use a narrowband receiver whose discriminator and low i-f stages are in good alignment. Position it some distance from the transmitter to be adjusted and have the transmitter operator gradually increase his deviation as he whistles loudly into the microphone. This insures that the transmitter limiter will be set to the maximum deviation level that can be copied. When the signal at the receiver just begins to break up (called "squelching out"), the deviation control of the transmitter should be backed off slightly. At this point, if the receiver doesn't squelch out on loud whistles, it will accept anything the adjusted transmitter will dish out in terms of audio level. For optimum system performance all transmitters should be similarly adjusted.

Reducing a wideband transmitter's deviation to make it compatible with a narrowband receiver is an unfortunate compromise. The performance of wideband receivers will be degraded substantially. Signal-to-noise ratios will fall off, reducing the sensitivity and the audio level, and increasing ignition interference and loud squelch tails. Remember to keep a limiting (loud as possible) audio signal modulating the transmitter throughout the adjustment procedure. Unless this is done the whole process is a waste of time.

Ken Sessions Jr K6MVH
Editor FM Journal
Ontario, CA 91762

Dear Curious,

Your letter on p.123 of June 73 is answered, yes. It was printed first in 73 (Nov 66), but my patent papers were filed 34 months earlier and the patent was issued in September 1966. The difference was that my write-up was not up to 73's standards and W4TDI's was. The question of angles and sunspots has never satisfied anybody. From October 1962 until February 1966 the sunspot numbers stayed below 30. The Bonadio antennas demonstrated their peculiarities during those years. Now, with the sunspot numbers a little over 100, they continue. None of these antennas have had any parts over 30 feet high, so the low angle of radiation is unresolved too.

George Bonadio W2WLR
373 East Avenue
Watertown, NY 13601

Dear Mr. Green,

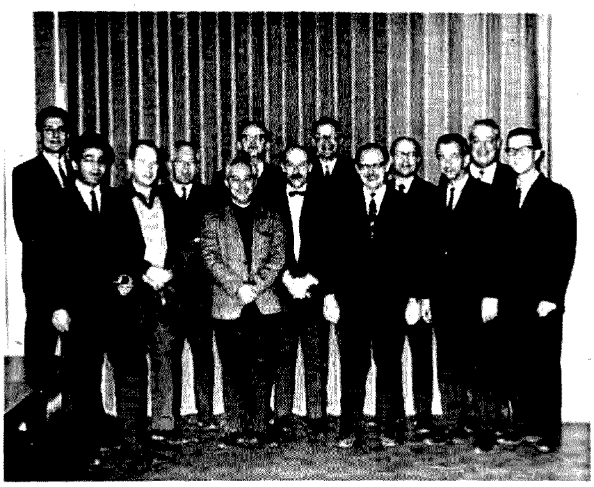
Reference is made to the February 1969 QST editorial and to Mrs. Bloom's article in the April issue of 73. I think Mrs. Bloom got a little off base, so to speak, in her article. QST's editorial referred to those who become involved in conversations which do not pertain to amateur radio; also the use of obscene language and offensive topics of conversation.

Despite what Mr. Hindin ("One Technique To Avoid That Routine QSO") states in the April 73, the best way to conduct a QSO and not risk any offense is to give rst, QTH, name, rig, wx, QSL, es tnx fr QSO, 73, SK. Who, in this day and age, cares that I am a schoolteacher, an Episcopalian, a Mason and a Conservative? To many people these are all dirty words and would cause them offense. It appears that people nowadays want no conversation; just be around people and say nothing. From one end of the country to the other the rule seems to be: be busy and don't talk at all.

Jim Ingham WN5VFW
2636 Forest Park Blvd
Fort Worth, TX 76110

Dear Editor,

The enclosed picture was taken at a recent meeting of the Radio Society of Iran. Left to right are DL2WB, EP2JP, W4GUS, WA5AUA, EP2 BF, EP2BI, EP2HL, Ted Libershal (QSL manager), WA9EHZ, WB4BSF, EP2DA, HC5HC, with EP2BG, EP3AM, EP2BQ, EP2FD, EP2DW, EP2CH and several other active EP's not present. All amateurs visiting Tehran are most cordially invited to attend these meetings, which are held on the last Thursday, monthly. Contact Chuck Bowers EP2CB at the US Embassy for information. EP stations are active on all bands, with 20 meters being the favorite. Listen nightly around 14225-14235 between 1230-1830 GMT. QSL cards may be sent to the Radio Society of Iran, Armish MAAG, APO, NY 09205.



Dear Wayne,

I have located the following Wall Street Hams: Jay Nathan K2HVM, Bioren & Co., 120 Broadway. Joe Re K1ZUV, Bear, Stearns & Co., 1 Wall Street. Herb Gesell WB2ASA, Stone & Webster, 90 Broad. Rob Robitaille WB2OTF, Eastman, Dillon, 1 Chase How about a shout from other Wall Streeters?

George Gero WA2FEF
First Hannover Corp.
67 Broad Street, NYC

Dear Wayne,

First let me congratulate you on the last few issues. I realize that you don't like being editor, but be assured that nobody can do the job like you do it. I hope you'll stay this time.

Wayne, I went down last week and passed the Extra and have since done some very serious thinking on the whole business. Naturally I am proud of having passed, but I've discussed a few ideas with friends on the air and we have reached the conclusion that if phase II of the incentive licensing is implemented in November the future of our bands will be very seriously threatened.

The intrusion into our bands of the ever-hungry commercial is bound to become more pronounced. In my area we are plagued by meatgrinder CW signals on 80M from Central and South Americans, and of course Castro's sandbar. They are all over the band and really thick around 3750-3800, the DX phone frequencies.

Despite many of us giving them hell, their activities have increased noticably during the last two years and can't do anything but get worse since so many hams are apathetic about the loss of their frequencies. The rejection of the Extra and Advanced Class licenses rather prove this.

We would like to petition the FCC to (1) Restore the bands lost by the General, Conditional, Advanced and Technician licensees and revert back to the bands as they were before November 1968. (2) Create an incentive by opening a new phone subband in the 80 and 20M bands, at least, with 25 khz for Extra and 50 khz for Advanced as a reasonable, but minimal incentive.

Having passed the test, I think I'm in a good position to ask for a change back. I feel that it would be foolish to continue and that our prime concern should be to save our frequencies. I challenge anyone to prove that there has been any reduction of lids or profanity on our bands...or any other major improvement as a direct result of incentive licensing.

Robert Wheaton W5PKK
Route 2, Box 324D
San Antonio, TX 78228

Ed note: Well, Bob, I suggest you forget the petition signatures and spend your time putting the problems and the proposed solutions to them on paper. Sign it, have it notarized, make 14 copies and send the works to the FCC. Send me a copy for 73 too, please. The time for signatures is when the FCC releases your proposal with a docket number...then it is either supported or not. I think your idea is a good one and will be glad to pass along your letters in 73. For that matter, even if I disagreed with your proposals I would probably pass them along in 73. Frankly, I wouldn't look for a lot of support from the ARRL, though I am always willing to be surprised.

Dear Wayne,

You might be interested in some portable operating I intend to do during the first two weeks of August on a trip through Central America, HK, YV, Trinidad, the Leeward and Windward Islands, KP4. South Caicos and the Bahamas. I will probably concentrate on 75M to give more of the fellows new countries on that band. I always enjoy 73 and like your style very much. Keep up the good work.

Charles Crow WB4MKU
1211 27th Place South
Birmingham, AL 35205

Dear Wayne,

For some time you have been sounding off on the importance of getting new hams and I agree that the situation is serious. Our local club, the Twin City Hams, in cooperation with the local college, has just completed offering a course leading to a Novice license (no college credit). I must say that we were amazed at the number of people who were interested in becoming hams. We had over 100 people attend and expect over 30 new Novices in the near future.

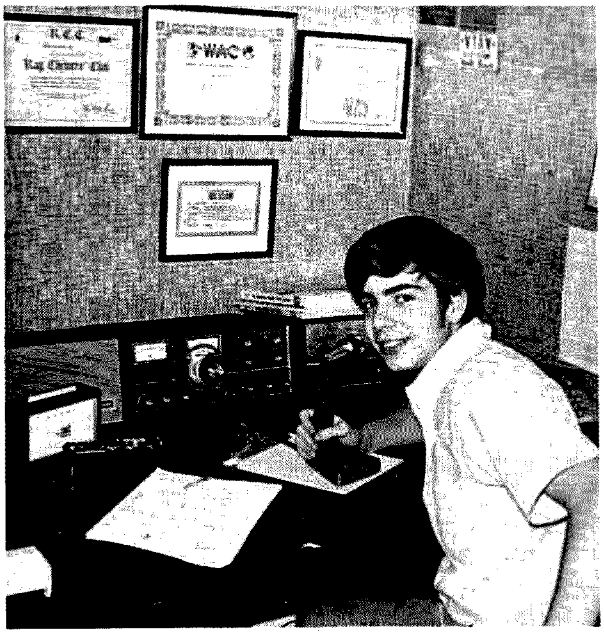
Record my vote for the new system of indicating propagation conditions.

William Gulledge K5UAR
700A Plum Street
Monroe, LA 71201

Dear Editor,

Your May issue was so good I can't express it in words. There were 40 (count them 40) great articles. I especially liked "In The Beginning." It ought to win the Pulitzer Prize for comedy! If you have more articles like that I might become a Life Subscriber. Say, if you need a photo to fill some space you might use the enclosed. I expect to have an article on working DX ready for you soon.

Donald Rubin WA3JRA



Dear Wayne,

Yeah, I'm mad, but not at 73. I think that the ARRL is going to wipe out ham radio for all but the ham who works in electronics or the hobbyist who is willing to spend all of his time studying.

To build up their advertising the QST boys have plugged for licensing everyone. Now they want to

void the investments in equipment of people like me. They want to cut off a lot of the use of the equipment they talked us into buying. Having been a ham since 1923 I have seen a lot of this hokus-pokus from the ARRL.

When is someone going to come out with an organization to replace the ARRL, which surely is now dead on the vine? I'll bet that the boys at headquarters haven't really been on the air twice in the last five years.

L.L.Bunning K6LOX
635 West 16th Street
Uplands, CA 91786

Ed note: Though the ARRL has seemed to many of us to have acted unwisely in the matter of incentive licensing and the net result has been, as you pointed out, a loss of investment for those amateurs who have as a result dropped out, I see no sign that the leaders of ARRL either planned things this way or even had a notion that their actions might bring this result. Incentive licensing was brought about, if I am to believe many consistent reports from deep inside HQ, by the intention of the League Mahager to use controversy as a means for calling attention to the League and thus getting more amateurs to become members. The plan back fired, of course, and the result has been a precipitous drop in membership. Once committed to supporting incentive licensing the League had to make it stick or else lose face. They made it stick.

You ask when someone is going to come out with an organization to replace ARRL? I tried rather hard to come out with an organization that would just try and do the things that ARRL refuses to do...support amateurs in legal difficulties, like poor W4GJO and his million dollar TVI suit, who has yet to receive one nickle in help from the ARRL...and to support a lobby for amateur radio in Congress so amateur radio would not be the only major user of frequencies completely without any lobby whatsoever. The result? A mere handfull of amateurs joined the Institute of Amateur Radio and there was not enough money to pay for even a part time secretary. Far more money was spent killing off the IoAR than was ever sent in as dues. The Washington Amateur Radio Newsletter (warn, get it?), whose only observable function was to smear the Institute and everyone attached to it, was widely distributed to thousands of amateur radio clubs and every member of the Institute. The newsletter stopped when IoAR ceased to function.

A new club cannot grow without the support of a major magazine. And a magazine trying to support a new club finds that there is a tight group of the top manufacturers fighting with QST every inch of the way. This is nothing to be surprised at, if you stop and think about it. If you were running the ARRL/QST complex what would you do if you saw a competitor forming? You would do everything in your power to cut them off. You would ask advertisers not to support the magazine with their ads. You would pass word down through directors to club members that the new outfit is bad...maybe even crooked...is not needed...may even hurt ham radio seriously...etc. This would be preached at thousands of radio club meetings, along with snickers at anyone foolish enough to suggest that the new club might be of any value at all. Anyone remember anything like that happening?

It will be a while yet before anyone will be starting a new club.

(continued on page 146)

Caveat Emptor?

★ **Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

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★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

★ **We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.**

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NEED A VARIABLE CAPACITOR for that homebrew project? We may have what you need at more than 50% below regular amateur net. Send for free flyer. A.R.C. Sales, 181 E. Wilson Bridge Rd., Worthington, Ohio 43085.

3 PLASTIC HOLDERS will frame and protect 60 cards, $1—or 10 holders $3. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, Tennessee 37066.

SPECIAL CLOSE-OUT SALE. Rectifiers, Transistors, and many other Electronic Parts. Lowest prices. Send 15¢ for Catalog. Electronic Components Company, P.O.Box 2902 S., Baton Rouge, La.

FOURTH ANNUAL Mini-Hamfest, sponsored by the Rockford Amateur Radio Assn., August 17, 1969, at the Boone County Fairgrounds in Belvidere, Illinois. Lunch and refreshments.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 mhy torroids 5 for $2.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

"TOWER HEADQUARTERS!" 11 Brandsl Heights aluminum 35% offl Strato Crank-ups-low costl Rotors, antennas and gear discounts. Phone patch $11.95. Catalog-20¢ postage. Brownville Sales Co. Stanley, Wisconsin 54768.

SB-34 TRANSCEIVER and SB-2 mike $245. RCA Fleetone 12 volt, 60 watt FM mobile on 52.525 mhz, $110. Alan Rutz, RR2, LaPorte, IN 46350.

POLICE/FIRE Dispatcher Directories. Call signs, frequencies; most areas available. Exclusive official listings. Stamp brings catalog. Communications, Box 56-ST, Commack, NY 11725.

ELECTRONIC TEST and Communications Equipment — Bargains galore. Send 25 cents for catalog. Palen Electronics, Box 1536, San Mateo,CA 94401.

GO MOBILE 115V power inverter. Low cost boat, auto, camping. In reverse becomes a battery charger. Plans $1.50. Ken Electric, 922 S. Toledo, Tulsa, Oklahoma 74112.

WRL'S USED GEAR has trial-terms-guarantee! KWM-1 — $249.95; HW-12 — $89.95; Swan 250 — $249.95; Galaxy 5mk2 - $279.95; Galaxy 300 — $139.95; SBE34 — $299.95; R4A - $319.95; Invader 200 - $249.95; HQ180AC - $349.95; CE100V - $259.95; AF68 - $49.95. Many more. Free "bluebook' list. WRL, Box 919, Council Bluffs IA 51501

POWER SUPPLIES $3.98. Nixies $5. Counter $2. $1 packages: capacitors, thermistors, zeners. Popular miniature sizes. Catalog. Murphy, 204 Roslyn Ave., Carle Place, NY 11514.

THE ANNUAL HAMFEST for the Washington DC metropolitan area, sponsored by the Foundation For Amateur Radio, will be held at the Gaithersburg Fairgrounds in nearby Gaithersburg, Maryland on Sunday September 21st, from 1000 until 1700.

THE FRRL SWAP N SHOP Hamfest will be held August 24 at Phillips Park, Aurora, Illinois. Free coffee and doughnuts from 9-10 AM. Fun for the whole family. Homing freq. 145.35 and 3.940 mc. For additional info contact Roger Louks, P.O. Box 93, Piano, IL 60545.

DANVILLE HAMFEST — August 31, Kickapoo Park, near Danville, Illinois. Advanced Registration $1. Tickets and information available from K9CDD, 508 W. Woodlawn, Danville, IL 61832.

THE SHAWNEE Amateur Radio Association will hold a hamfest Sunday, August 3rd at Herrin City Park in Herrin, Illinois. Trading, prizes. Tickets—Bill Johnson, 502 Kennicott, Carbondale, IL 62901

TELEPHONE DIALERS (2) Prestodial. Stores 36 telephone numbers and automatically dials any one at push of a button. New @ $119. Richard Jacobs WAØAIY, 4941 Tracy, K.C., MO 64110.

WARA 12th annual Hamfest, Sunday August 24th, Newton Falls Community Center, Newton Falls, Ohio. Take Ohio Turnpike to exit 14 and ask for map to Hamfest. Prizes, XYL activities, Swap and Shop. For further information write W8VTD, Box 809, Warren, Ohio 44481.

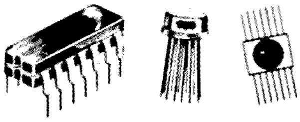
WANTED — a used Instructograph with tapes. K8UZG H Crawford, 302 Going, Pontiac MI 48058

THE EAST COAST VHF SOCIETY 11th annual free outdoor picnic-hamfest will be held Sunday, August 10, at Saddle Brook Park (NJ) starting at 10 AM. Write Box 1263, Paterson, NJ.

3 INPUT DUAL AND GATE

Brand new factory marked and packaged PHILCO-FORD IC's. Flat pack, long leads, each nested in its own plastic protective snap-lid shipping pack. 3 input dual AND gate. We furnish circuit diagram and lead connections. A real bargain for factory first-line material.

#69-100 3 for $1.00; 12 for $3.00



GRAB BAG IC's

Mixture untested IC's, flat pack, dual inline, TO-5. Most factory marked. Package of 12 units W/10 pages RTL and DTL specs. **$2.00**

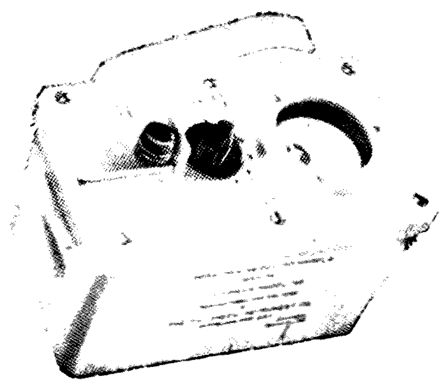
Customer pays all shipping

New catalog #69 now ready

Send 25¢ handling & postage charge.

VARACTOR SIMILAR TO MA4060A

Good for 40 watts at 432 MC, ea. tested in circuit, w/diagram for 432 MC tripler. **$5.00 ea.**



GEIGER COUNTER, MLTRY SURPLUS

like new with book, untested

SURPLUS SPECIAL **$10.00**

IBM WIRED MEMORY FRAMES.

Removed from high priced computors. Exlnt condition.

4,000 Wired Core Plane	$ 9.00
4,096 Wired Core Plane	$12.50
8,000 Wired Core Plane	$13.50
8,192 Wired Core Plane	$15.00
16,384 Wired Core Plane	$19.00

JOHN MESHNA JR.

19 ALLERTON ST., LYNN, MASS. 01904
P. O. BOX 62, E. LYNN, MASS. 01904

FOR SALE: Heathkit-sized home brewed linear. Four 811's in G-G. Commercial grey Pref. Cabinet. Excellent construction. Schematic. 1 KW CCS. Extra tubes. $125. Drake 2B with 2BQ speaker/Q-multiplier console. Good condition. $150. Twelve 416B/6280 (gold construction) tubes for very low noise UHF preams. One socket. Make offer. Gary Boucher, 246 Maple Avenue, DuBois, PA 15801.

TRADE or SELL Knight Kit V-107 VFO. Still in box. Use with TR-106 or 108. Want CB rig.. R. Hazel, Box 183, Stony Ridge, OH 43463.

SELL: HEATH RX-1 Mohawk, TX-1 Apache, SB-10 SSB adptr, spkr, relay, mike—complete station $225. PC62b 6&2 mtr xcvr, 12 & 110 pwr, vfo, $115. MC300 + 6&2 mtr xvrtrs, calib.,FB $170. 2 el 40 mtr beam + tribander + 30 ft self-standing twr $100. 4 el 6 mtr beam + rotator + 30 ft mast, $40. Carl WB6RXC, 213-283-5296.

W-I-M-U HAMFEST August 1-2-3, Mack's Inn, Idaho, 23 miles south of West Yellowstone, Montana, Calling all Wyoming, Idaho, Montana & Utah hams!

THE IOWA 75 METER phone picnic will be held in Anson Park at Marshalltown, Iowa, August 17th. All activities will begin around noon.

KNIGHT TR-108, factory aligned, mint, 2 crystals, $110 or ? Also SX-101 and Viking 500. Make offer. Jim McClure WA9BYR, 627 Dundee Ave., Barrington, IL 60010.

SX-111 HALLICRAFTERS receiver, used less than 100 hours, brand new condition, $135. Richard Kempfbeck, 203 Dix Hills rd, Huntington Station, NY 11746.

SWAN 500C, power supply, 508 VFO, VOX; Swan 250C, power supply, VOX, Manuals. Very new. Still under warranty. 25% off list. Will ship. Box 189. Advertiser:you sent no address. Please advise.

TECHNICAL WRITERS and editors needed. Freelance, various electronic topics. Send resume. Electronic Writers and Editors, Inc. P.O.Box 504, New Hyde Park, NY 11040.

JOB WANTED. Some engineering education. Marketing degree. Successful selling experience. Various abilities. Advanced, second phone licenses. 39. divorced, can relocate. Box 289, c/o 73, Peterboro, NH, 03458.

WANTED: Jan and Feb 1961 73 Magazine. I can swap with other copies or your price paid. Eskil Persson SM5CJP, Frotunagrand 1, 19400 Upplands Vasby, Sweden.

DALLAS AREA Ham-Swapfest—Texas Instrument Activity Center, Sunday, September 14, 1969, 9-5. Prizes: Swan 350C, TH-6, plus many more—Pre-registration prize - register now - $2/person - John Zagrodnick, 3823 Antique Drive, Dallas TX 75234.

73 Assistant Editor Position Open

Here is an opportunity to earn a modest living while working at your hobby. You'll be living in fabulously beautiful New Hampshire, well away from the rat race, and learning about publishing and printing. Please include details of your amateur radio background with your resume.

(continued from page 141)

Dear Wayne,

This is the last straw—my mailbox couldn't take it! I am indebted to someone for sending me down a stash of some 30 copies of 73 Magazine. Unfortunately they chose to arrive on Home Field Day when I had a shack full of hams, so I had to wait until those magazine-happy hams went home. I have since read them from cover-to-cover and all full of interesting news and circuits. I want to thank you folks for sending them down to me.

Our interest in Project Oscar is taking a severe knockback, with no reliable information available to us. I have been running our ZL-Oscar Net every Monday evening for 104 weeks now, and it sure takes some doing to hold a net together for that long without any information to pass out. The boys in VK quit answering mail about ten months back, and it was like finding gold in the streets to extract some information on what was going on. From all accounts things are at a real low ebb with Oscar. I have just received a letter from VK2APQ which indicates that yet another group is getting into the act and that Australis-A may yet be tossed aloft. Our shattered confidence makes us ultra-cautious about project "Moonray."

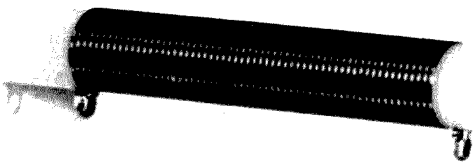
My 432 mhz converter is rough-looking, and evolved from that circuit you published. I had to use tubes in the oscillator chain. I have a home-made coaxial tank amplifier which I used on Oscars 3 and 4. I had several reception reports from VK and ZL, but no two-way contacts. Those were great times and our group had a fine time chasing Oscars.

Bruce Rowlings ZL1WB
New Zealand

INDEX TO ADVERTISERS

A Unique RF Plate Choke

Bill Deane, W6RET
8831 Sovereign Rd.
San Diego, California 92123



A unique rf choke.

At times it is difficult to obtain the exact *rf* plate choke that one may desire for a new final amplifer. In looking for a material to make a 2 ampere 5000 volt dc *rf* plate choke for non-ham use, I came across a material made by DuPont called Delrin. Delrin has high strength but can easily be cut and drilled. It has excellent electrical properties as an insulator with a high heat distortion temperature. These features make it an excellent form for *rf* plate chokes and other coils. Delrin is available in rods of 1/4 inch to 1 1/2 inch diameter and can be purchased in 12 inch lengths. The 3/4 inch diameter was selected for the choke and is available from Allied radio for $1.42 per foot (Allied part 60D9565CF).

The choke shown in the photograph is 5 1/4 inches long. The terminals of the coil are No. 8 brass cotter keys 5/8 inch long. The form is prepared by drilling the two terminal holes on a 4-inch spacing 5/8 inch deep, using a drill slightly smaller than the cotter key size. A 11/32 or 3/8 inch hole is drilled down the center of the rod to a depth of 3 3/4 inches. A 1/2 inch deep hole is drilled in the opposite end of the rod with a 29 drill. This hole is tapped for a 8/32 mounting screw. A 3-inch piece of .33 inch diameter ferrite rod (Lafayette 32C6102) is inserted into the hole and held in place with a few drops of epoxy. Next force the cotter keys into the form holes using a vise or by tapping lightly with a hammer. Sixty turns of No. 20 formvar wire is space wound (15 turns per inch) on the form with the coil ends soldered to the cotter key terminals. The space winding can be accomplished by a dual winding of No. 20 wire and then removing one winding. A light coating of coil dope will hold the turns in place.

The completed choke has an inductance of 90 uh, loafs along at 2 amps, has a Q of 225 at 3.6 mhz and has a series resonance well above the ham bands at 43 mhz.

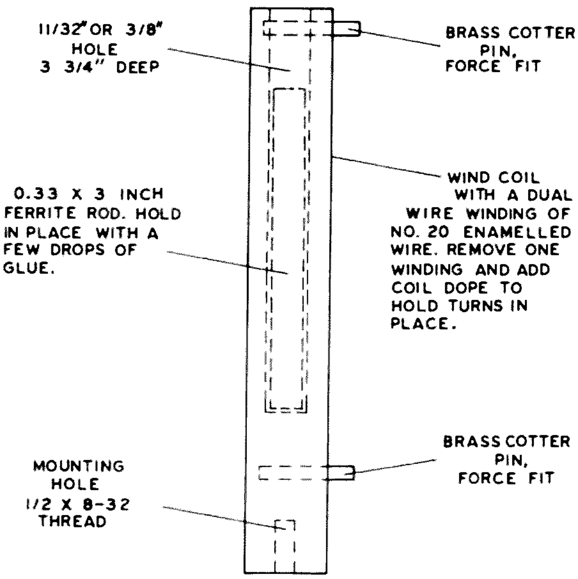


Fig. 1. Diagram of completed 2 amp 5000 volt rf choke using DuPont "Delrin."

If you do not wish to build a choke with the ferrite rod and will be limiting your plate requirements to 800 ma at 2500 vdc, a choke can be wound on a 3/4 X 4 3/4 inch rod with No. 24 formvar wire closewound to occupy 3 1/2 inches. This choke has an inductance of 90 mh, a Q of 160 and a series resonance of 25 mhz. My thanks to Don Bidwell for his photograph of the choke.

. . . W6RET

Modification of the ac Input on the SB-200

Al Brogdon, K3KMO
RD 1 Box 390A
State College, PA 16801

The Heath SB-200 is a real gem, giving top performance per dollar in a linear amplifier. There are few ways it could be improved, but one feature which falls into the "needs improvement" category is the ac input arrangement.

In the original amplifier, terminal strip "S" has the wires from the power transformer's two primary windings connected to it. To change between 120 Volt ac and 240 Volt ac operation, it is necessary to change jumpers on this strip. This in itself isn't bad, but the ac line plug arrangement is not too good.

Heath outlines the use of a single plug for both 120 Volt ac and 240 Volt ac operation. This is the standard three-contact 120 Volt ac safety plug (two wires plus ground). This could lead to the sad situation of having a 240 Volt ac outlet in your shack which looks like a normal 120 Volt ac outlet, and plugging in a piece of 120 Volt ac equipment with pretty bad results.

To avoid this problem at K3KMO, I installed a 240 Volt ac circuit with a normal 240 Volt ac receptacle, and changed the line plug on the SB-200 to match the outlet. But then came the time I wanted to take the SB-200 to a friend's shack where only 120 Volt ac was available, and I was faced with the prospect of having to change line plugs, re-wire the jumpers on terminal strip "s" to make the change, and then do the same thing again when I brought the SB-200 home.

Rather than do this and be faced with the prospect of doing it other times, I decided to change the SB-200 to come up with an arrangement for simpler change-over. I placed an Amphenol 86PM8 male octal plug on the rear deck of the chassis, where the line cord had previously exited. Fortunately, there is just enough room on the chassis lip to accommodate this connector. I then wired the four leads from terminal strip "S" plus a ground wire to this plug as shown in Fig. 1.

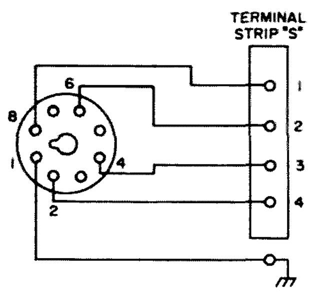


Fig. 1. Wiring changes in the SB-200, from terminal strip "S" to the new power connector (Amphenol 86PM8).

Then two line cords were prepared for the linear, one for 120 Volt ac operation, and the other for 240 Volt ac. The 120 Volt ac cord is the original SB-200 power cord with the plug supplied by the manufacturer. The other end of the cable is terminated in an Amphenol 78PF8 female octal cable connector, wired as shown in Fig. 2a. A second power cable was prepared using the 240 Volt ac plug on one end, and another octal connector on the other end, this time

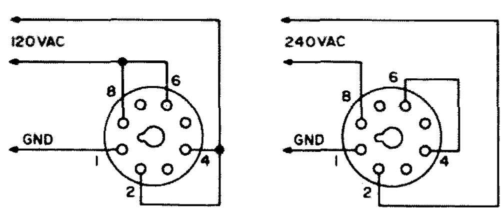


Fig. 2. Connections for the two line cables to mate with the new power connector.

wired as shown in Fig. 2b. Notice that with both power cables, the ac input is connected to the proper transformer leads, and the appropriate jumper connections are also made in the octal connector.

Therefore, the change from one input voltage to the other requires only that the appropriate ac input cable be connected. Caution: Be sure all jumpers are removed from terminal strip "S" when this modification is made.

If you are building an SB-200 from the kit, this change can be incorporated as the amplifier is being built, eliminating terminal strip "S" completely. The transformer primary leads and capacitors C1 and C2 can be wired directly to the octal plug. Be careful not to cut the transformer primary leads off too short by following the instructions for normal wiring. Just wait and cut them to length when you're ready to connect them.

This same approach can be used with any piece of equipment which has provisions for either 120 Volt ac or 240 Volt ac line input. And other types of connectors can be used according to your personal preference.

. . . K3KMO

LETTERS

Dear Wayne,

There were several omissions in the schematics of the "Six Meter KW Linear" in the July issue. The most important are as follows:

Page 21. 1. Coil data not given–should be 3 or 4 turns of 1/8" copper tubing, 1" diameter, spaced to resonate with the chosen capacitor.

2. There should be a connector in series with one lead of K1–this goes to the N. O. contacts of the exciter PTT relay.

3. R2 is 100K, ½watt.

4. Cathode pins 2 and 4 should be grounded in addition to pins 6 and 8.

Page 23. 1. Note 4 should read transient rather than equalizing.

Many thanks for the new tower and antennas, the cassette tape recorder, the trip through the Heath factory, and the other things 73 has bought for me in the year I have been sending in fillers. They are very much appreciated. I hope I will be able to supply similar material for "73 Junior."

Would 73 be interested in a short article on the subject of how semiconductor grade silicon is produced?

Bill Turner
Five Chestnut Court
Saint Peters, Missouri 63376

No . . .ed.

Dear Sir:

We thought it may be of interest that there is a new net on the air for emergencies and DX contacts. The world DX Round Table operating on 14270 KC Wednesday and Saturday from 0500-0800 GMT.

All QSL's for net contacts may be forwarded to (WA5UHR) net QSL manager.

Scott Freile
1510 Lynnview
Houston, Texas 77055

Dear OM Wayne,

I was given "DX-Handbook" first-edition from my good friend WA9NKG, "Paul" & find it a very nice book, especially I enjoyed the article about 80 meters DX. Here in JA, there are not so many DX's on 80 meters, only JA6AK is active. Hi. By the way I found some misunderstanding on page 90, "Call Areas." Please correct as follows:

JAPAN	Wrong		Right
JA1	Kanto, Shinetsu	JA1	Kanto
JA2	Tokai, Hokuriku	JA2	Tokai
JA9	Fukui, Toyama, Kanazawa, Ishikawa	JA9	Hokuriku
JAØ	Nagano, Suwa, Niigata	JAØ	Shinetsu

JA9 includes three prefectures; Fukui, Toyama, & Ishikawa, and Kanazawa is capital city of Ishikawa, like Phoenix in Ariz! JAØ has two prefectures; Nagano & Niigata, and Suwa is the name of one city in Nagano!

About 7 or 9 years ago in JA, there were only 8 areas from JA1 to JA8, and then JA1 & JA2 were divided into two till then JA1 had Kanto & Shinetsu, JA2 had Tokai & Hokuriku, but since then Shinetsu changed to JAØ & Hokuriku got JA9 calls, so you might use the old date! Hi! Anyway now you are all right!

Another info here, you wrote "for DX Watch for gigantic do-it-yourself coloring map," on 22 page. We can buy do-it-yourself map for DX from our JARL. About 55x80 cm ¥ 200 (about 60¢) with great circle map. This map is very nice for DX hound! You may get the map if you send about $1 to JARL, P. O. Box 377, Tokyo.

Oh, one more info, JA1 area got too many hams and they needed another call so they used JH1. It was two or three years ago. And now JH1 also going away the newest call right now (29 June '69) is JH1VZZ and JH1Y . . . JH1Z . . . is used for club stations so the rest is JH1WAA to JH1XZZ, when all of these calls used, they use JR1. First JR1 will go on the air in '69!

Narumi Kawai, JA9APS
1-10 Suwanokawara
Toyama-City 183, Japan

Dear Wayne,

I read with interest the article on facsimile and the radio amateur by Ralph Steinburg K6GKX in June, 1969. (I also had an article starting on page 130.)

You should know that facsimile and slow scan TV are exactly the same thing electrically if you add a horizontal sync pulse to the facsimile signal.

I have been running slow scan TV for the past 2½ years (one and a half years under the special slow scan TV license), using facsimile equipment. As far as I know, this is completely legal since I am conforming in every way to the various television kinds of signals that are being sent. Those who are receiving the slow scan TV signal using facsimile equipment can use the horizontal sync pulse if they wish. Those receiving the slow scan TV signals on a CRT presentation, generally require the sync pulse. Those that are receiving them on facsimile machines, do not need it.

Mr. Steinburg's statement, "with slow scan television legal on the low bands, facsimile may be the next mode of communications to follow in the near future. All it needs at the present time is enough interest by the radio amateurs to show the Federal Communications Commission, by petition, that facsimile will contribute to the state-of-the-art," really impedes matters by continuing the fiction that there is a difference between facsimile and slow scan TV.

J. R. Popkin-Clurman, W2BK
1623 Straight Path
Wyandanch, New York 11798

Dear Wayne,

Up until the past few months, very little effort had been made to attract youngsters into our ranks and it is indeed regretful that we have been so tardy in promoting amateur radio to this particular age group. Editorials in some of the amateur magazines have at last recognized the severe lack of youth-intake in amateur radio and soberly suggest that we make strong efforts to try and introduce these young people to ham radio.

Some may ask, "Why is youth so important to amateur radio?"

There are a multitude of good reasons why amateur radio needs new blood and certainly each reason has its own merits. To mention but two, we might start with what amateur radio as a hobby can provide for a youngster just getting started in ham radio. It offers a youngster the chance to convert his spare time from roaming the streets, lying idle on the couch, etc., to something constructive, educating, challenging and rewarding. For some, amateur radio can lead to a very successful career in electronics later in life. Amateur radio in the years to come, will need new amateurs to improve the state of the art and in general to man the helm. Todays youthful prospective amateurs will be the people to assume this task. This is why it is of cardinal importance that all amateurs do their utmost to familiarize the youth of today with ham radio.

Today's youth are basically a good group of people and they have a tremendous amount of potential and energy which if could be directed to the area of amateur radio, would lead to an eventual license and a genuine feeling of accomplishment and satisfaction.

Boy Scout Explorer posts, high school radio clubs, camps and other outlets have time after time graduated the prospective young amateur from training in code and theory, to an amateur license. However, these organizations lack the ability to make the initial contact with a youngster and this is where the individual amateur must help out.

One may ask at this point, "Well, what can I do?"

Get in touch with the youngster down the street and invite him or her over to the shack. Fire up the rig and explain how it works. Show them your collection of qsl's—let them have a try at the mike—show them what an amateur license looks like—be patient and encourage them, and most of all, let them know that you sincerely want to help them. You might then direct them to a local radio club or some other group that teaches code and theory classes for future hams. If there isn't any such group in the area, then you, yourself, could certainly help these young people. Five wpm and elementary theory and regulatory material certainly isn't difficult to teach to eager students, is it? They will always admire you for your guidance and assistance, believe me.

While amateur equipment becomes more and more sophisticated, and with DXpeditions and contests taking up a substantial amount of our hamming time amongst other facets of amateur radio, let us not neglect the youth around us for they certainly hold a share in ham radio's future.

The initiative is up to you. Ham radio is a very fascinating and rewarding hobby and has so very much to offer. Why not get in touch with the youngster down the road and lend the helping hand they need and at the same time, strike a blow for amateur radio.

Ralph J. Irace, Jr., WA1GEK

Dear Wayne,

Thanks for the articles by K1YSD. Many moons have passed since I laughed so hard. As a result of your fine articles on the Advanced Class License I passed my test.

Tom Shirley, K4HVV
410 Patton Road
Hinesville, GA 31313

Dear Editor,

Would any members of the American Cryptogram Association who are readers of "73" drop a line to the writer? The intent is to form a net to discuss crypto systems and solutions.

Thank you.

Herbert S. Dunkerley, WA3JIX
RFD 2
Jeannette, PA 15644

Dear Wayne,

I have finally rounded up a bunch of information on the recent beginners course in ham radio and a photograph of some of the instructors and graduates. Only 17 of the 28 who received a novice ticket are on the picture, but that was the best that I could do.

As for the course, here are the bare facts: Enrolled–109, Attended 6 or more lessons–48, Attended less than 6 lessons–61, Quit after attending 6 or more lessons–15, Earned Novice ticket–28, Attended whole course but not passing exam–5, Oldest earning ticket–69 years, Youngest earning ticket–13 years.

The course ran for 16 weeks. There was one hour of lecture on theory and one hour of code instruction each week. The first eight or nine lectures were on basic radio theory and regulations, and the last seven or eight were on specific topics: antennas, transmitters, power supplys, etc. Most of the basic theory was taught by Charlie DePoe, WA5VQR, a professor at the local college, who also kept the vita[1] statistics throughout the course. The specific topics were taught by various members of The Twin City Hams radio club, some of whom are in the enclosed photo.

I taught the code portion of the course. It was designed for the beginner and started at zero wpm. At the end of the course the average speed of those finishing was about 7½ wpm, with a couple of the fast learners copying around 15. The code practice was recorded on magnetic tape prior to each

Recent FCC News

RM-886. The ARRL has requested that the CW-only band on two meters be moved from the high end of the band to the low end, 144.0 – 144.1 mhz. It has been the custom to use only CW in this lower 100 khz of the band, however, it may be worthwhile to make this into law if there are too many operators that refuse to honor the convention. It seems a shame that we have to make federal laws just to force a few inconsiderate operators to conform to custom.

RM-950. The ARRL has requested the opening of 28.0 – 28.5 mhz for F1 emission. This is RTTY which is now restricted to the CW portions of 80-40-20-15 meters. It should have been allocated that way in the first place. It is nice to see the ARRL behind this request . . . they were the principle opposers to the original requests for F1 on the low bands and managed to delay the FCC ruling on this for several years.

RM-981. A petition has been filed with the FCC to open all bands from two through 80 meters to maritime mobile while in Region 2 and to open 3.5 – 3.8 and 7.0 – 7.1 mhz for maritime outside of Region 2. At present maritime ops are permitted to use 40 thru 2 meters in Region 2 and 20-15-10 meters outside Region 2. Seems reasonable enough.

RENEWAL CODE

The two numbers under your call on the address label are the expiration code. We have tried to make it simple. The first number is the month that we send you the last copy on your subscription and the second number is the year. 78 would be July 1968, for example.

session to keep sending errors and resulting confusion to a minimum.

Everyone in the club agrees that the course was an unqualified success and that we all learned a great deal from it. It is still hard to believe that so many people are interested in amateur radio and are just looking for a chance to get into it. Any club can do itself a lot of good by encouraging people with a genuine interest.

Now, can anyone tell me how to keep 28 brand new Novices on the air?

Bill Gulledge, K5UAR
700A Plum Street
Monroe, LA 71201

Dear Wayne,

Since working as Chief Engineer of KALX (FM), my perspective on the Amateur license technical examination has changed. Many people will agree that it is a simple and uncomplicated task to pass the technical section. But in comparison with the First Phone exam, it is hardly a test at all.

You might note that the Amateur license is just that: for amateurs. But what has this done to the quality of the average ham? One can simply listen to the low bands any evening to provide the answer.

The degradation in quality has been brought about through the lack of respect in the ham license. Years ago it took real perseverance and intelligence to be a ham operator. There were no readily available stations, as today. Kits, if any, were almost the same as building from scratch. And when the ham was finished with a piece of gear, a receiver perhaps, he had a sense of pride, a sense of accomplishment. Today, the closest thing to that most hams experience is the sense of relief one feels when the last payment is made on a complete transceiver. Too, there was a feeling of fraternity. There was belonging, brought about because there was a great hurdle that everyonr had to pass to become a ham: the building of a transmitter and receiver, and the exam.

Today the exam is not difficult. And today the only comradeship most hams feel is in their mutual animosity towards CB'ers. Little wonder that the bands should be in such poor shape. When one loses respect in something, one is not apt to take good care of it.

One good way to make an Amateur license more valued is to require a stiff technical exam, one that would require actual studying, not memorization sessions with the License Manual. But the more difficult technical skills it engenders would prove greatly beneficial to the ham, and the country. It might even save the Amateur Radio Service.

I'd like to hear your comments on my letter.

Stephen L. Diamond, Radio KALX
500 Eshleman Hall
Berkeley, California 94720

Caveat Emptor?

★ Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

★ Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.

★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

★ We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

★ For $1 extra we can maintain a reply box for you.

★ We cannot check into each advertiser, so Caveat Emptor . . .

SPECIAL CLOSE-OUT SALE. Rectifiers, Transistors, and many other Electronic Parts. Lowest prices. Send 15¢ for Catalog. Electronic Components Company, P.O.Box 2902 S., Baton Rouge, La.

3 PLASTIC HOLDERS will frame and protect 60 cards, $1—or 10 holders $3. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, Tennessee 37066.

WANTED ANTIQUE RADIO and wireless equipment. Also radio magazines of teens and twenties. Also buying supply catalogs, Duck, Manhattan! etc. Farrell, 2252 Dixie Pontiac, Mich. 48055.

THE ANNUAL HAMFEST for the Washington DC metropolitan area, sponsored by the Foundation For Amateur Radio, will be held at the Gaithersburg Fairgrounds in nearby Gaithersburg, Maryland on Sunday September 21st, from 1000 until 1700.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 mhy torroids 5 for $2.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

"TOWER HEADQUARTERS!" 11 Brandsl Heights aluminum 35% offl Strato Crank-ups-low costl Rotors, antennas and gear discounts. Phone patch $11.95. Catalog-20¢ postage. Brownville Sales Co. Stanley, Wisconsin 54768.

TECH MANUALS, and service data for Surplus Electronics. Thousands of publications on hand, covering communication and test equipment. Sorry—no catalogs, but will rush price and availability quotes for specific literature that you may need. Propagation Products Co., Box 242, Monroe Street Post Office, Jacksonville 1, Florida.

OHIO VALLEY 6 meter phone net 50.350 every Sunday. 2000 EDT, WA8WIW, NCS Sciotoville, Ohio. Traffic and Rag Chewers Welcome.

FIND OUT about the New Greene Balun. Read all the details on page 59 of this issue. Greene Balun, Warfield, R.I. o2880

WANTED: TECHNICAL material. Corp model XFK freq. shift exciter for Tmc model GPT 750—also TMC single sideband exciter, model SBE for GPT 750 & manuals—plus 18 to 30 foot parabolic dish. What will you take for it in place of money—will swap brand new towers or test equipment. Write, wire or call: Eugene Leger, Hollis St., East Pepperell, Mass. 01437.

SELL: COLLINS KWS-1, Ser. 896, $640; 75A4, Ser. 5763, $420—or both for $1025. I will ship. Lew Hindert, Rt. 4, Box 290, New Braunfels, Texas 78130.

WANTED: CR tube for Tektronix 561 or 561A oscilloscope. Sell: Collins CC-2 Carrying Case, $50.00; TMC Commercial TTG-1 two-tone oscillator, $95.00; Kepco SC-18-4M transistorized power supply, 0-18 VDC, 0-4 amps, 0.1% regulation, metered, $110.00; Bird 6254 R-F watt meter, 0-2 watts, 30-500 mc, 50 ohms, $50.00; Bird 67 R-F watt meter, 0-25/100/500 watts, 30-500 mc, 50 ohms, $125.00. FOB, H. T. Cervantes, 34 Johnson Rd., Binghamton, N. Y. 13905 (607-724-5785).

CHRISTIAN Ham Fellowship now organized for Christian fellowship and gospel tract efforts among Christian licensed amateurs. Christian Ham Callbook, $1.00 donation. For details and sample copy of ham gospel tract, write to Christian Ham Fellowship, P. O. Box 218, Holland, Michigan 49423.

WANTED TEST EQUIPMENT: Bird watt meter, measurements of G. R. sig. gen. up to 450 mc; Tektronix scope. State price. W2EDN, 93 Gilmore Ave., Binghamton, N. Y. 13901.

WRL'S USED gear has trial-terms-guarantee! KWM1-$249.95; HW32-$89.95; Swan 250-$249.95; TR3-$369.95; NCX3-$169.95;SB34-$299.95; Galaxy V-$229.95; Galaxy Vmk2-$279.95; Ranger-$99.95; HT32A-$259.95; 100V-$259.95; Galaxy 2000 linear-$329.95. Many more. Free "blue-book" list. WRL, Box 919, Council Bluffs, Iowa 51501.

WANTED: Turret Turner with coils or old chassis with Turner for Hammarlund SP400X receiver. Later model with 13 plate stator & 14 plate rotor. Ralph M. Williams, Box 372, Dixfield, ME 04224.

SELL HALLICRAFTERS HT-32 Transmitter, excellent condition inside & out, $210. Will deliver within 50 miles. Want Collins 32S1 or 32S3. Robert Kujawski, WA2VDX, 30 Rose St., Florida, N. Y. 914-651-7212.

GREENE . . center dipole insulator with . . or . . without balun . . see September 73 issue.

HAMS WHO LIKE audio, too, try new quarterly: Amplifiers by Williamson and Bailey, speaker by Baxandall. Details, Audion 307 Dickinson Ave., Swarthmore, PA 19081.

CINCY STAG HAMFEST: The 32nd Annual Stag Hamfest will be held September 28, 1969 at Stricker's Grove, Compton Road, Mt. Healthy, Cincinnati, Ohio. Door prizes each hour, raffle, lots of food, flea market, model aircraft flying, and contests. Identify Mr. Hamfest and win prize. $5.00 cost covers everything. For further info., contact John Bruning, W8DSR, 6307 Fairhurst Ave., Cincinnati, Ohio 45213.

Increase Your Grid Dipper Range

There is general agreement that a grid dip meter is an invaluable piece of amateur test equipment. Why then confine its use to the usual frequency range of 2 or 3 mhz to perhaps 250 mhz when it is some easy to make additional coils to cover the lower ranges?

Browsing through the catalogs will quickly convince you that hardly anyone sees fit to supply low frequency coils and when they do it is at additional cost. Why not make your own? All that is necessary is a base which will fit the coil socket of your dipper, a coil form or two, and a little patience. My current dipper is a Heath GD-1 (which I find superior to several others I have had around the shack) which requires a two-pin coil base. In my case I had only to bend two lengths of copper tubing to the proper spacing for the coil terminals at one end and the socket spacing at the other. After the proper frequency range was established, the entire coil and about a half inch of the leads were potted in casting plastic, making a very sturdy assembly.

The low cost coils I used (5 cents each at a local hamfest) came equipped with a ferrite slug. I left the slug in for the lowest range – 250 khz to 1 mhz and took it out of the higher range – 1 mhz to 2 mhz. No exact data can be given due to the variation in dipper circuitry. This will be a case of pure "cut and try." The range of the new coils must be plotted on a graph against the original dial markings.

A general coverage receiver will allow calibration down to 550 khz and by feeding the signal into its *if* strip, an additional point at approximately 450 khz is obtained. Below that frequency things get a little tougher. If you happen to have a low frequency receiver, fine, if not, use harmonics in the BC band.

William P. Turner, WAØABI

SEPT. 1969
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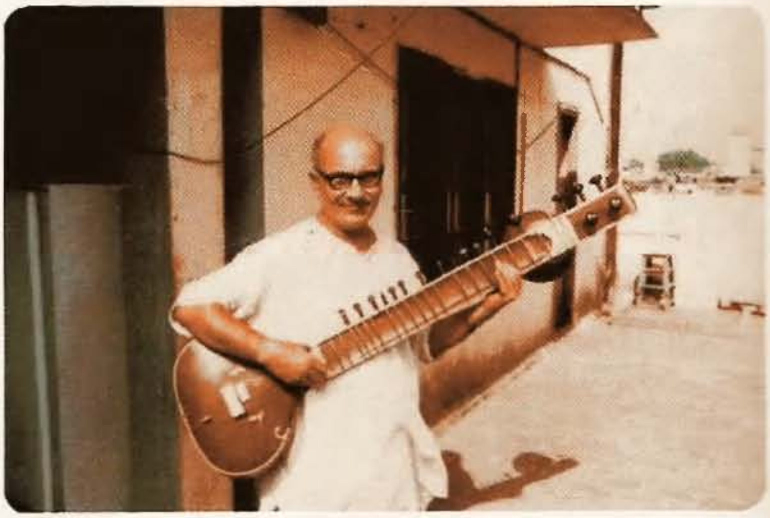
AMATEUR RADIO 73

WORLD'S LARGEST INDEPENDENT HAM MAGAZINE

160 pages 160

40 FEATURE ARTICLES 40



Cover
Burma: X22KN
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STERBA CURTAIN
TUNNEL DIODES
AFSK Generator
VHF-FM

73 MAGAZINE
PETERBOROUGH, NEW HAMPSHIRE 03458

73 Magazine #108, September 1969

Contents

Features

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...de W2NSD/1

Wayne Green

Our New Magazine

Last month I mentioned briefly that we are planning to start a new magazine for debut this fall. Since we are depending very heavily on you, the readers of 73, for articles for the new publication, perhaps I should tell you a little more about it.

The idea is to put out a magazine which can be read by the general public and which will carry them on up through the Novice License. 73 is far too technical for the beginner and we are hoping that a magazine can be put out which will fill in this gap.

Remember back to when you got started in radio as a hobby. The chances are pretty good that you started out either in CB or as an SWL, depending mostly on when you got into the game. I went the SWL route myself, but I am quite sure that if I had come along during the CB era that I would have entered through that door. Both CB and SWL can be fun . . . a lot of fun. Both could, I believe, use an adult magazine to help people get more fun and education out of these aspects of radio.

For instance, have you seen any articles about listening on much more than the broadcast band or the short wave broadcast stations? What about VLF? I'd like to have readers send in articles on listening to some of the more offbeat bands . . . ship-to-shore, police, fire, CAP, doctor calling, telephone, aircraft, etc. And how about some articles on using RTTY gear for tuning in the ham bands, news broadcasts, stock market, weather, foreign languages, and other interesting services. Used FAX machines are available inexpensively now and can be used for copying Tiros directly . . . or FAX broadcasts of weather maps and other items. I think there is enough going on to provide interesting articles for a long time to come.

The beginner won't be able to build very much, so I think we should try and concentrate on telling him how to buy commercially available equipment and accessories . . . how to use it . . . what you can do with it . . . how to hook it up . . . and anything else they should know about it. This goes for all of the CB transceivers, antennas, test accessories, tuners, and gadgets, as well as converters, tuners, receivers, etc., for SWL. CB'ers want to know how to install equipment in their car and how to make it work the best possible way. They want to get every milliwatt out of their system at home or mobile. They want to know all the things they can do with their CB gear that are legal and how to avoid being illegal with it. They should be encouraged to work their way up to amateur radio if they find the need to get on the radio and talk for the fun of talking. That's what ham radio is for and CB isn't for.

Since we will be covering radio up through amateur Novice, we will be looking for articles on Novice gear and on Novice operating. I'd like to see a lot more straight from the shoulder articles which will help Novices enter our hobby with a better understanding of amateur radio. Too many of them get hung up with poor equipment which spoils their fun, just because they don't know any better than to scrimp on the receiver.

The time is already growing short and we are getting the first few issues of the new magazine ready for publication, so get busy writing and let's see if we can turn the tide and not only provide a lot more fun for those coming into radio as a hobby, but encourage them to go on to amateur radio.

If you don't feel that you have an article to write, perhaps you would like to volunteer yourself to answer questions from readers? Send me your name and address and let me know what particular type of questions you can handle in particular, and I'll list you as one of the Technical Advisory Group. Readers will be requested to send their questions to

(continued on page 66)

George Cousins, VE1TG
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Lower Sackville, Nova Scotia

A DX Curtain For 15 Meters

If you can afford a nice beam, complete with tower, rotator, coax, and all that sort of stuff, then no doubt you can get on 15 meters and enjoy all the DX you want. This article is probably not for you. But if you happen to be a Novice with limited funds or a family man who can't afford a major installation, then maybe you should read on a few minutes and see if you have found a solution to your problem with a very simple antenna that will take a back seat to no-one.

I've picked out 15 meters to talk about because it's the band a lot of beginners depend upon for their first taste of DX, but the antenna I'm going to describe could just as easily be built for any other band. As a matter of fact, I even built one for 40 meters a few years ago – now, *there* was a monster! (*CQ*, Nov., 1962).

The antenna I'm talking about is called a Sterba Curtain, named after a gentleman called Mr. Sterba who obviously liked building antennas very much. Although you may have heard of these marvelous arrays being used in great stacks by such people as international short-wave broadcasters, point-to-point stations, etc., don't be alarmed. Like many such arrays, they all start out very simply, and we'll keep them simple for our purpose.

The Sterba Curtain which I use right here on 15 meters was built from start to finish in a period of about three hours. It cost about $5. I put it up alone, and it works like a charm on QSOs from here to Australia and most places in between. All you have to do is measure out some wire reasonably carefully and put it together in the pattern shown in **Fig. 1**. This is a simple, single-section Sterba, which is all you need to get started. Observe the dimensions: it's small enough to hang on a normal lot and needs only a couple of supports which can be very light – trees or poles because there is practically no weight involved. If you have a little extra room and would like some more gain, then you can extend the antenna by inserting more sections in between the small end sections, as shown in **Fig. 2**.

Now that you're convinced and ready to get going, let's take a look at materials. The wire is easy; just ordinary copper, about No. 10, 12 or 14, as long as it can support its own weight. These sizes should be easily obtained from any motor repair shop or electrical store. The insulators can be pieces of hardwood dowel if you haven't the proper porcelain ones, and the phasing lines can be pieces of 300 ohm twin lead or TV ladder line. The latter is best because it's wider spaced and will stand up to higher power and the rough treatment of the

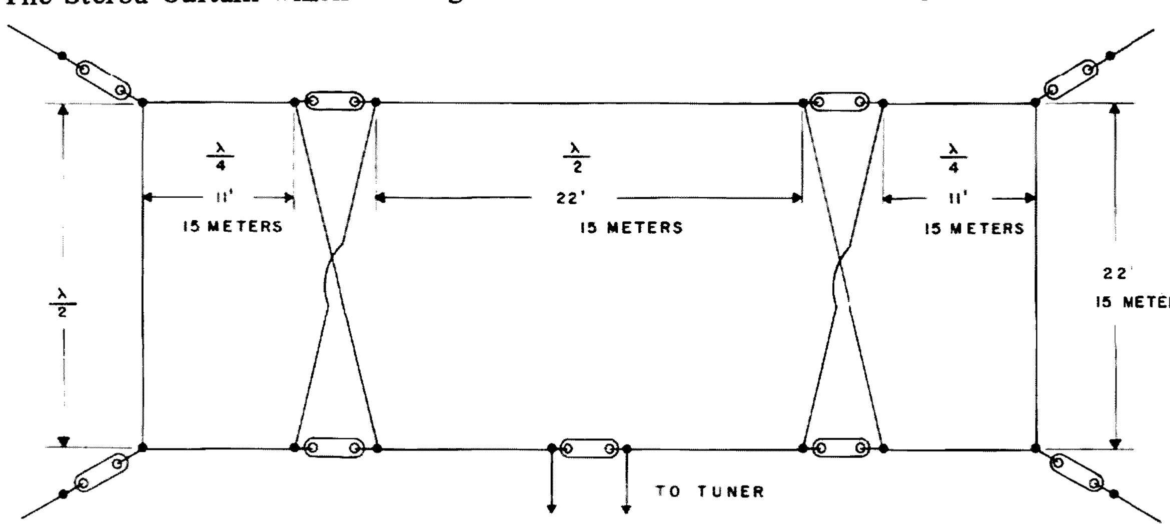


Fig. 1. Basic single section Sterba Curtain.

weather much better than the ordinary twin lead. If you have neither, then use some of the leftover wire and make your own line, using small hardwood dowel for spacers and keeping the wires from 2 to 4 inches apart. Don't forget to *transpose* the phasing lines!

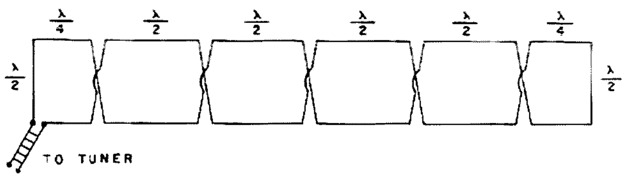


Fig. 2. Multi-section Sterba Curtain.

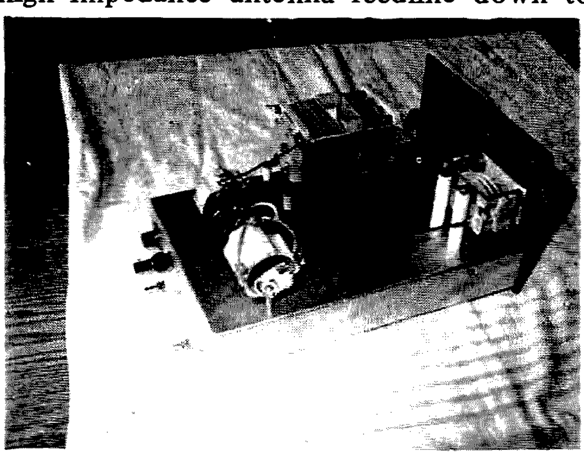
Dimensions are not critical; just be sure that all the half-wave sections are the same length, and likewise the quarter-wave ones. The feedline can be attached to either point shown in **Fig.** 1 or 2, whichever is most convenient physically.

Once the thing is built and pulled up in the air, you may find you haven't much height between the bottom elements and ground. Will it comfort you to know that mine is only 5 feet off the ground? No? Well then, how about tilting the whole antenna by pulling back on the bottom element until it hangs at a 45° angle? This will work fine, will raise the bottom a few feet higher, and may even give you a little lower angle of radiation for long-haul DX.

Now attach the feedline (some more of that ladder-line stuff already mentioned), and connect it to the output of the tuner.

"*Tuner!!* Aha, Martha, I *knew* there was a catch to this yarn!"

Well, after all, you have to change that high impedance antenna feedline down to



Antenna tuner used with the 15 meter Sterba Curtain. The large split stator capacitor is connected in parallel to form C1, while the small capacitor is C2. The ceramic form is mounted firmly to the chassis, with input and output connectors on the rear apron. The weatherproof plexiglass covers have been removed for the photo.

that low impedance coaxial output from your rig, so let's not make a big fuss about it. The tuner is a pretty small item, and it tunes so broadly you can just leave it out in the yard under the antenna, and run a small coax cable from it to the rig. **Fig. 3** shows the tuner diagram, and the photo shows its construction. Just a tuned circuit for the band you're using, and a high-capacity variable to tune out the reactance of the coax line. Wind the coil on a ceramic or plastic form, and be sure to insulate CI from the chassis and panel. The size of the

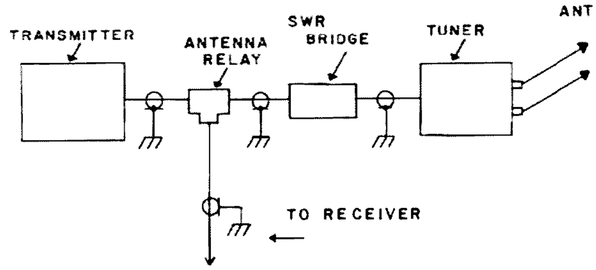


Fig. 3A. Complete set-up of tuner and SWR bridge.

capacitors shown in this tuner will handle the maximum legal power on any mode, but for lower powered rigs they can be much smaller, as long as the actual capacitance is the required value.

Tune-up is very simple. Connect the rig as shown in **Fig. 3** and feed a little power into the coax line. Resonate the rig's plate circuit, set the SWR bridge to Forward, and adjust it to a maximum reading on the meter. Then switch the meter to Reflected and adjust both capacitors in the tuner until the meter indicates a minimum SWR (lowest reading). There will be some interaction between the tuner controls and the rig's plate tuning, so be sure the plate circuit

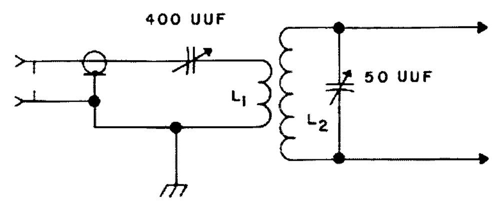


Fig. 3B. Tuner schematic. LI—3T. #10, 2½" I.D. interwound with L2. L2—6T, #10, 2½" I.D.

remains in resonance, and readjust the tuner several times to make sure the SWR is as low as possible. It should come down to almost 1:1 and will not shift higher than about 1:1.5 at any point in the band.

As a precaution against weather, I had to enclose my tuner, so I made a case out of a couple of pieces of plexiglass sheet. This can be cut and formed easily and fastened

together with small bolts or glue. Even a little careful work with a propane torch will do the job, as the plexiglass will melt and the edges will weld themselves together. And it will *never* rust!

So there you are with a fine antenna which cost you almost nothing except a few hours' work (enjoyable), and now you can go ahead and catch some very fine DX on 15 (also enjoyable). For adaptation to other bands, just cut the wire to the correct size and change the tuner coil, and you're all set. In fact, a 20-meter version will work well on 20, 10 and 40, if you make an all-band tuner to go with it. Gain will be about 3 to 4 db from a single-section affair, but it'll be almost all low angle radiation, and that's the real secret of DXing. Have fun!

... VE1TG

Stabilizing 40 Meters in the NCX–3

The 40 meter section of the VFO in my NCX-3 had been drifting downward and it had been difficult to have a good QSO. Sometimes it travelled as much as 10 khz. New components (capacitors and a coil), sent from National without charge, failed to correct the situation while checking the voltage regulation on the bench and in the car showed that the fault was not in that area. With the help of some new "freeze" spray material I located the trouble in the slug of the coil.

To compensate for that change in inductance as warm-up occurred I first substituted new temperature compensating capacitors of the original values. This failed to help. I next substituted various values of capacitors, each with different temperature coefficients. Soon the oscillator drifted upward which indicated that I was on the right track. After hours of trial and error I reduced the drift to about 1 to 2 kHz upward on warm-up. The final capacitance across the coil, not including the trimmer and tuning capacitors, was 150 pF NPO and 25 pF N470. I do not believe that I can stabilize the oscillator much more and I have had no more complaints of offensive drift. I pass this along with the hopes that others having the same difficulty may profit by my hours of work.

Gay E. Milius, W4NJF

Tunnel Diodes -- Theory and Practical Applications

Dennis J. Lazar, K8TSQ
3494 Tullamore Road
University Heights, Ohio 44118

"Say, OM," said the Kid, dashing into the shack one day, "I've got a real puzzler for ya."

The OM put aside his worn soldering gun. He carefully brushed a bit of dust from the framed Amateur Extra Class ticket hanging above his bench and swiveled on his stool to face the young novice. He regarded the boy with cold, steel grey eyes while he lit his rough briar pipe. The fingers of one hand drummed an unconscious CQ upon the bench top. "Ok," he growled at last, his lips taking up the hint of a wise smile, "What's the problem? *Rf* amps? Receiver dead? Want to put up a quad?"

"It's those new solid state gadgets called tunnel diodes." The young ham leaned forward, breathlessly expectant. "What do they do?"

The OM snorted and sucked hard upon the battered pipe he held clenched between his teeth. "Why son," he exclaimed, "those varmints oscillate, switch, amplify, rectify and emulsify. and they'll do it all at once if you give them half a chance."

"Yeah, that's what I've heard," said the Kid, quivering with enthusiasm. "But how? Why? What kind of circuit? Huh?"

"Well, ah," the OM puffed sharply a few times, fell into a fit of coughing and sent a box of nuts and bolts spraying across the shack. "Dang it!" he exclaimed. He watched the Kid from the corners of his shifty eyes as he eased his bulk to the floor, calloused hands searching after the wayward hardware. "Look Kid, come back next week. As you can see, I just don't have the time. Yeah, next week I'll give ya the whole story."

"Here, let me help you." the Kid began to retrieve bolts from under the KW rig in the corner.

"No, no," the OM wheezed. "I'll take care of this. You take off. Go work DX. Go play in traffic. On 80 meters," he added hastily.

The Kid could take a hint. He sullenly stalked out of the shack, resolving that he would return next week and pin the Old Man down.

Meanwhile, even as the door slammed behind the young visitor, the OM was hot-footing it to the library where he began an intensive search which left him grumbling into his whiskers. Every book had a little of the scoop on tunnel diodes, but none told the whole story, at least not the type of story he needed to be able to update the Kid. Scratching his head and furrowing his brow, he cast about for insight. At that moment a bell rang within, the sun came up over the mountains, and light flooded into the OM's fog-enshrouded mind. With a grin of confidence and faith, he struck out for home in search of that amateur fount of knowledge, his back issues of *73*. There nestled among the dusty tomes he found it:

Tunnel Diodes

Here is an opportunity to end the mystery about a tiny device with many big uses. A device with only two terminals that will oscillate, amplify, switch and multivibrate, the tunnel diode can perform these feats with close to no power applied.

The tunnel diode is smaller and faster than an electron tube or transistor. It is relatively unaffected by heat, radiation or vibration. Moreover it is inexpensive. Prices start at a dollar.

The usefulness of the tunnel diode is due to its peculiar property of negative resistance which is caused by a phenomenon known as the "tunneling effect."

To understand the workings of a tunnel diode one must first be familiar with those of an ordinary semiconductor diode. To

comprehend the latter, one must understand the atomic structure of semiconductors in general.

Atomic Theory Of Semiconductors

An atom, the basic unit of matter, consists primarily of a nucleus having a positive charge and one or more electrons, each having a negative charge circling about the nucleus. These electrons occupy orbits at differing distances from the nucleus (**Fig. 1**).

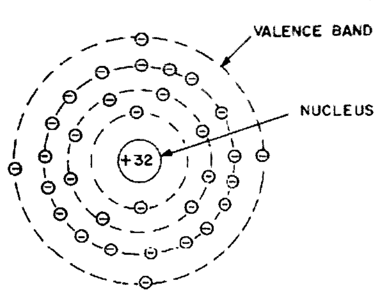


Fig. 1. Germanium atom.

Each orbit represents an energy level of the electrons within it. In other words, an electron in the orbit nearest the nucleus has an energy level or charge of -X. An electron in the second nearest orbit would hold a charge of -2X, and so on. The number of electrons and energy levels depends upon the particular element. The electrons of the inner three levels, or orbits, in Fig. 1 are of relatively low energy and are tightly bound to the nucleus. Electrons in the outermost orbit or "valence" orbit are of high energy and are some what shielded from the nucleus by the inner electrons.

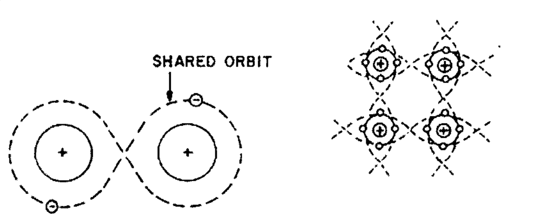


Fig. 2. Lattice structure.

Because of their conditions, the valence electrons are bound loosely to the nucleus and may be borrowed by another passing atom or shared between two atoms, thus forming a covalent bond between the two.

In a semiconductor, many atoms are bonded together to form a crystal structure (**Fig. 2**). These atoms are so tightly packed that their individual energy levels merge to form "bands" of energy between which lie "forbidden regions" in which electrons cannot exist.

One of these energy bands is the valence band made up of the valence electrons previously mentioned. Electrons in this and higher bands are free to move about in the crystal lattice.

When an electron moves, it vacates the space that it had occupied and a "hole" remains in its place. This hole represents a positive charge equal in magnitude to the electron's negative charge. We regard it as an entity in itself however, since as electrons jump from one empty spot to another, the space, or hole, seems to be moving in the opposite direction. Thus we say that holes are positive charge carriers and flow in a direction opposite that of electrons. **Fig. 3** illustrates this effect.

In a crystal, with no external power applied, all possible vacancies in the valence band are filled with electrons and the crystal looks like an insulator. However, as energy is applied, electrons in the valence band gain enough energy to pass to the next higher energy state, or the "conduction band." To do this enough energy must be supplied to the electrons so that they can overcome the forbidden region or energy gap between the bands.

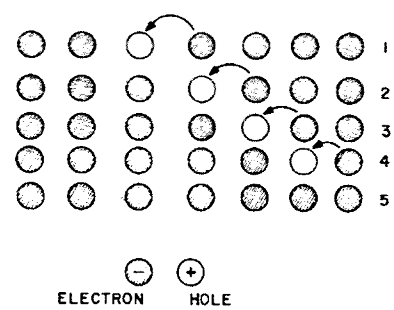


Fig. 3. Charge carrier flow.

Once boosted into the conduction band, which is empty, the electrons may flow freely. At the same time, the holes remaining in the valence band "flow" in the opposite direction.

A solid may be an insulator, conductor, or semiconductor depending on the width of its energy gap. In a conductor, there is no gap. The conduction and valence bands overlap.

The semiconductor's energy gap is small enough so that, given a boost, electrons can enter the conduction band. (0.7 electron volts for germanium; 1.1 electron volts for sillicon).

An insulator has a gap so wide that electrons cannot enter the conduction band without an extremely large applied voltage.

In semiconductor devices, crystals are "doped" to obtain specific properties. In

doping, atoms of an impurity are substituted for atoms of the crystal substance. The impurity is chosen to have one more or one less electron in its outer (valence) band than the atoms of the crystal. If it has one extra, it can bond with the crystal atoms and have one free electron which can be easily excited into the conduction band. This material is known as N-type.

If the impurity has one less electron than the crystal atom, it takes one from the crystal atom to complete the covalent bond. This leaves a hole. The material thus has an abundance of holes and is known as P-type.

The Semiconductor Diode

To fabricate a semiconductor diode, a germanium or silicon crystal is doped with N and P type impurities to form a PN junction. The energy gaps on both sides of the junction are equal but the potential energy of electrons on the P-type side is higher than that of electrons on the N-type side. Thus there is a "potential barrier" between the two **(Fig. 4)**.

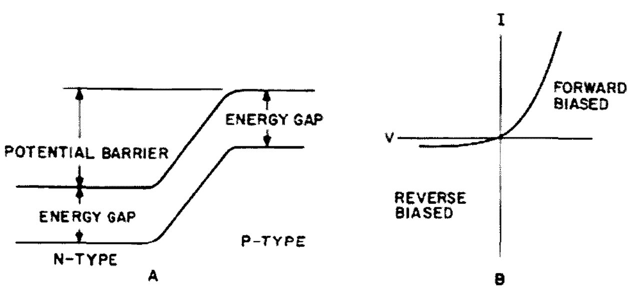


Fig. 4. Potential barrier of diode and I-V characteristics.

When the diode is reverse biased, with a battery connected negative to P-type, positive to N-type, the barrier grows larger and little current flows. However, when forward biased, the barrier becomes smaller and forward current increases with increasing voltage applied **(Fig. 4B)**.

The Tunnel Diode

A tunnel diode, unlike normal diodes, has a much narrower barrier region due to higher doping levels. This difference accounts for the tunneling effect which takes place in this device.

An electron, to climb over the potential barrier must have energy greater than that of the barrier. However, there is a possibility that if the barrier is narrow enough, some electrons will pass or tunnel through it. This tunneling effect gives the tunnel diode its name and its unique properties.

With no external potential applied to the tunnel diode, electrons from the conduction band on the N-type side can tunnel through the barrier to the P-type valence band and vice-versa. At zero bias these two currents are equal and thus balance each other such that there is zero net current flow **(Fig. 5A)**.

When the diode is reverse biased, the energy levels on the P-type side are increased in relation to those of the N-type side. Since there are many vacant energy states on the N-type side exposed to P-type electrons, a heavy tunnel current flow results from the P to N-type side of the barrier. Reverse current varies exponentially with reverse bias voltage and a heavy current flows with very small reverse voltages applied **(Fig. 5B)**.

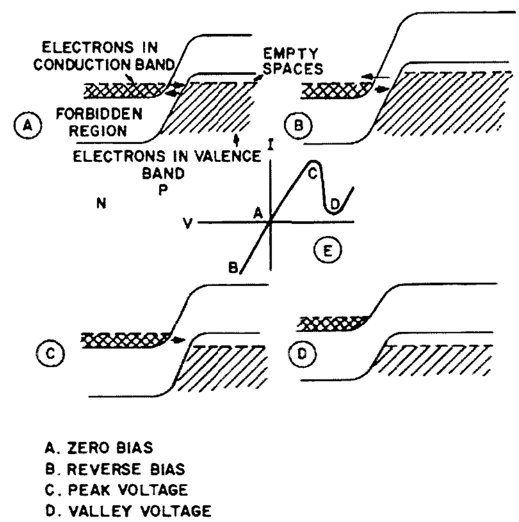


Fig. 5. Energy band diagram of tunnel diode junction.

In the forward-biased mode, energy levels on the N-type side are increased with respect to the P-type side. With a small forward bias **(Fig. 5C)**, N-type electrons are opposite empty states in the P-type area, and tunnel current will flow. The valence electrons in the P-type region are opposite the forbidden region, and thus no current flows in the reverse direction. There is, therefore, a net forward current flow.

As forward bias is increased, tunnel current increases until a point of maximum current (peak point) is reached. Above this point, the N-type valence electrons begin to move opposite the P-type forbidden zone and tunnel current decreases. A minimum value is reached (valley point) at which time tunnel current ceases and increasing forward bias decreases the height of the barrier, allowing conventional forward diode current to flow.

Fig. 5E illustrates the current VS bias voltage relationship in the tunnel diode. Point C is the peak point where maximum

tunneling occurs. As voltage is increased past this point, net current drops until the valley point is reached (D). This decrease in forward current with increasing forward bias voltage is the negative resistance characteristic which enables the tunnel diode to function in so many ways.

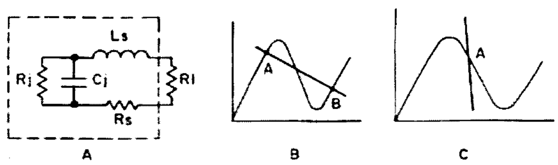


Fig. 6. Equivalent circuit.

Tunnel Diode Circuit Applications

A tunnel diode may be used as an oscillator, switch or amplifier depending upon circuit values and applied voltage. The parameters which determine the mode of operation are **(Fig. 6A)**: series resistance, load resistance, junction capacitance, series inductance, and negative resistance of the tunnel diode. These may be combined into two parameters:

$$a \text{ or Alpha} = (R_s + R_L)/R$$

and

$$\beta \text{ or Beta} = (R_s + R_L)RC_j/L_s$$

The value of Alpha determines whether the diode will operate as a switch. With Alpha greater than one, the diode acts as a bistable switch since the load line intersects the I-V characteristic at two stable points **(Fig. 6B)**.

With Alpha less than one, the diode can be used as an oscillator or amplifier depending upon the values of both Alpha and Beta.

In **Fig. 6B**, it can be seen that the load line intersects the I-V characteristic at two stable points. If the circuit is biased to operate at point A and a positive current pulse is applied, the operating point shifts to point B. A negative pulse switches the circuit back to point A. Thus the diode functions as a switch. This ability is often utilized in computer logic circuits.

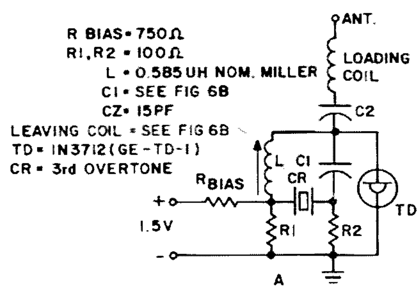
Fig. 6C shows the load line intersecting the characteristic at only one point, this being in the negative resistance region. This load line will provide the conditions necessary for the tunnel diode to operate as an oscillator. The location of the point of intersection or operating point is determined by signal swing, signal-to-noise ratio, and operating temperature range desired.

The greatest signal swing may be realized by biasing at the center of the linear portion of the negative resistance slope on the curve.

A higher current point should be chosen for high temperature operation or a low current point for best signal to noise ratio. It is thus obvious that to meet one requirement, another must be compromised. In designing a working circuit, values must be chosen which will best satisfy all operating conditions.

Tunnel diodes can operate at frequencies in excess of 5000 mhz at low cost and high efficiency. These devices are valuable as low-powered oscillators at microwave frequencies. Of course they will perform very well on any amateur radio band. For ham uses, the oscillators should be crystal controlled to prevent oscillation on spurious frequencies.

The basic crystal controlled oscillator utilzes a standard quartz crystal operating in its resonant mode across an L C tank circuit. To enable the circuit to oscillate, proper bias must be supplied such that the tunnel diode operates near the center of the linear portion of its negative resistance slope.



C1 =		LOADING COIL UH
144MHZ	20PF	0.1
50MHZ	2.2	0.65
28MHZ	58	2
14 MHZ	240	9
7 MHZ	900	32

B

Fig. 7. Basic crystal controlled oscillator.

In **Fig. 7**, R bias and R1 form a voltage divider which supplies bias to the circuit. With the crystal removed or the circuit out of resonance, R1 does not allow enough current to flow through R bias for a proper voltage drop to take place. Thus the diode is not biased in its negative resistance region and oscillation will not occur. At resonance, the crystal appears as a short circuit and thus R2 is shunted across R1, the total value of resistance than becoming half that of R1 alone. The voltage divider, R bias, R1 and R2 now provides proper biasing and the tunnel diode begins to oscillate. This circuit insures that the diode will not oscillate at any frequency other than the crystal frequency. If allowed, the diode is perfectly capable of oscillation at a number of different frequencies at once. Obviously this is not a desirable situation.

Fig. 7 provides circuit values for a crystal controlled oscillator making use of a GE TD-1 tunnel diode. This device operates at ± 180 millivolts (.18 volt) and draws approximately 1 milliamp of current. The oscillator as a whole operates from 1.5 volts at a current of 2.5 milliamps. This takes into account the power dissipated in the voltage divider. This circuit alone, if connected to a good antenna and keyed, will surprise you. As many QRP operators will testify, a very little power can and often does go a very long way.

A Solar Powered Transmitter

The tunnel diode transmitter is an ideal device to power with solar cells. Usually a single photovoltaic cell or perhaps two will suffice. The above oscillator can operate with the power derived from a common two cell flashlight beam focused upon a single solar cell.

Many types of solar cells are available to fit this application. Lafayette electronics lists two in their latest catalog. The SIM silicon solar cell has an output rating of 0.3 to 0.4 volts at 10 to 16 milliamps in sunlight while the B2M sun battery generates 0.5 volts at 2 milliamps. Both sell for around two dollars. As one can see from the ratings, the first cell has a great deal more current capability than the latter. In selecting solar cells, one should keep in mind that the ratings given are for full sunlight and that they may be greatly reduced should clouds appear. Arrays of cells are also available having cells wired together in series or in parallel or both. One such array is the Hoffman HSSP-2-40 Silicon Solar Module. This device consists of a number of cells, interconnected and packaged. The output of this module under full sunlight is 2 volts at a current of 42 milliamperes. The Hoffman module is available from Newark Electronics Corp. at the nominal price of $5.50.

One problem encountered in solar cell operation is that of maintaining stable output voltage. The tunnel diode, being very sensitive to bias level, will not operate above or below its proper biasing point. The light input to a solar cell normally varies over a wide range of intensities and therefore output voltage would likewise vary. To compensate for this, some means must be incorporated to clamp the output at the proper level. This is accomplished through use of a transistor as a shunt regulator.

A germanium transistor, the GE 2N404, was selected due to its sensitivity to low voltage and its low cost (58 cents).

The circuit in Fig. 8 utilizes a solar cell supplying voltage in the range of zero to 500 millivolts. The tunnel diode transmitter must have an input of 150 mv for proper operation. The regulator circuit must therefore be capable of holding the voltage from the solar cell constant at this value.

When solar cell voltage is below 150 mv, the transistor is "off" and appears to the circuit as an open. Above 150 mv, the transistor becomes increasingly forward biased due to the voltage divider made up of the two resistors in the circuit. With increasing forward bias, the device conducts more heavily and thus appears to the circuit as a shunt resistor whose resistance decreases with increasing applied voltage above 150 mv. In this way, voltage above the bias point of the tunnel diode is dropped across the transistor and bias is held constant for all values above 150 mv.

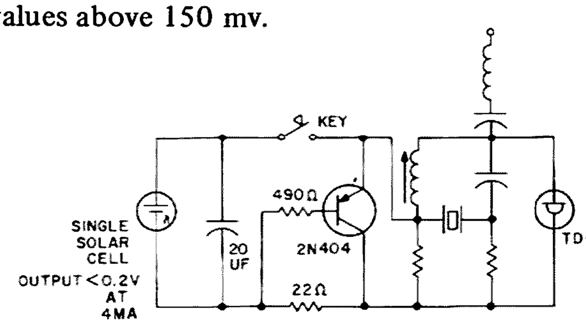


Fig. 8. Solar powered CW transmitter.

The 20 microfarad capacitor in parallel with the solar cell filters out any noise which may be picked up by the light striking the cell's surface. Fluorescent lighting will modulate a flashlight beam causing a 60 hz hum to be impressed upon the transmitted carrier.

Many interesting experiments may be undertaken which make use of modulation of a beam of light. The transmitter may be modulated in this way or keyed by interruption of the light source.

A crystal controlled tunnel diode transmitter, modulated by a transistor is shown in Fig. 9. Here a TD-3 diode has been used to take advantage of its higher output capability. This circuit is shown operating from a battery but it may be adapted to solar power if desired through use of a voltage clamping circuit such as that previously discussed.

The TD-3 tunnel diode draws 4.7 ma with a bias of 125 mv. Thus the input power to the stage actually used by the diode would be .58 milliwatts.

All capacitors should be chosen to be as physically small as possible. Voltage rating is not important as long as it exceeds two

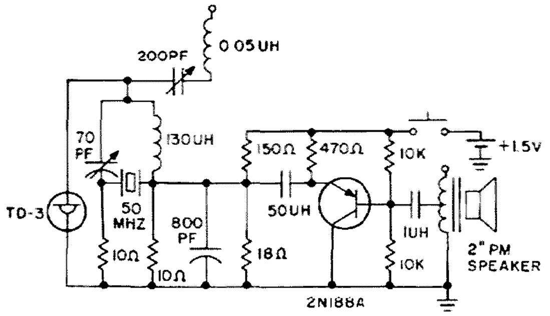


Fig. 9. 50 mhz phone transmitter.

volts. This device makes use of a bias network similar to that used in the transmitter in **Fig. 8**. Therefore it will not operate on frequencies other than that of the crystal.

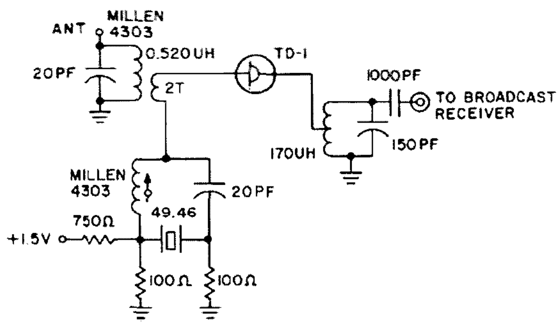


Fig. 10. 50 mhz converter for auto radio.

Tunnel Diode Converter

The converter in **Fig. 10** is of the "self oscillating" type. Using a single tunnel diode as both oscillator and mixer, this circuit will hetrodyne a 50 mhz input signal down to the broadcast band. System sensitivity is ± 4 microvolts at 1 mhz. The circuit may be operated from single solar cell power supplies and would make a fine companion for the CW transmitter in **Fig. 8**.

Needless to say, there are many devices that would benefit from the use of tunnel diodes in their design. Their low cost, low power requirements, and many functions make them a natural for the experimenters bench.

Well now OM, why not get out and buy yourself a few TDs and show the Kid that hams are not just switch throwers and knob twisters. Heat up the old iron and find out what its all about. You'll have a ball.

. . . K8TSQ

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Scottsdale, Arizona 85257

The Magic T

If you have been disappointed with paralleling *rf* power transistors in an attempt to get more power output the magic T could be the answer to some of your problems. Paralleling transistors in *rf* power amplifiers quite often does not yield the expected result; that is, double the power output. Unless the transistors are closely matched, one transistor will usually hog the drive power while the other(s) loaf along at best. You may even experience a loss of power unless you are very careful. Moreover, if one transistor fails there is a total loss of power output. The solution: Use Magic T at both the input and output to isolate the transistors.

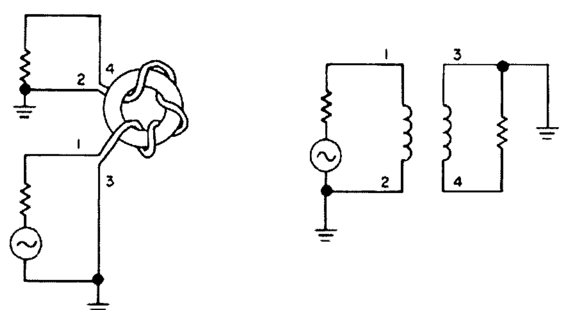

Fig. 1A. Simple reversing transformer can be used to drive push-pull amplifiers from a single-ended source. It also forms the basis for most of the other broadband transformers. Six turns of twisted (about ten turns to the inch) No. 24 enameled wire will work well at vhf-uhf on a T50-10 core. For lower frequencies use T50-2 core.

Broadband Transformers

Back in 1959, Ruthoff[1] described a series of broadband transformers wound on ferrite cores. Ruthoff achieved some rather fantastic bandwidths with most of his suggested transformer configurations. He achieved bandwidths from a few thousand khz to 800 mhz. He described several balun configurations which have been used quite extensively by amateurs and others. But, some of the other transformers including the hybrid or Magic T, have not been utilized to their fullest extent.

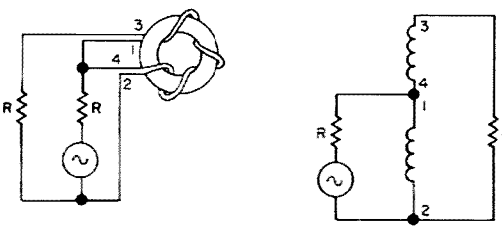

Fig. 1B. This 4:1 impedance transformer is very useful in transmitters to transform impedances. Five or six turns of No. 24 wire twisted together. See Fig. 1A for cores. As will be shown later, this transformer is great for boosting transistor impedances to a more useable level for matching.

Since copies of the above-mentioned article are not readily available to the average amateur, some of the popular configurations are reviewed in **Fig. 1** including the popular baluns to provide a ready reference.

The ferrite hybrid shown in **Fig. 1E** is a

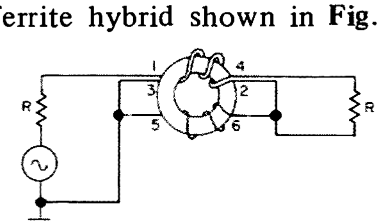

Fig. 1C. Unbalanced-to-balanced transformer (Balun) with a 1:1 impedance. The winding is the same as Fig. 1A with an extra winding to complete the magnetizing current path. For a KW balun in the 3 to 30 mhz range, wind a set of three biflar turns of No. 14 wire on a T200-2 core. For lower power requirements at vhf, use the lower-cost T50-10.

carryover from the familiar microwave waveguide Magic T. See **Fig. 2.**

Before discussing the waveguide hybrid Magic T, let's look at the general form of a

hybrid as shown in the black box of Fig. 3. A signal applied to terminals A and C is delivered to B and D with no direct transmission from A to C or C to A. Likewise, signals applied at terminals B and D are delivered to A and C with B and D being isolated from each other.

In the waveguide hybrid, the above discussion holds; that is, a signal at 1 and 2 is divided equally between P and S with 1 and 2 isolated from each other. Also, if ports 1 and 2 are terminated, power applied at P or S is divided equally between ports 1 and 2.

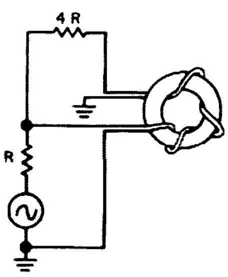

Fig. 1D. 4:1 balun. This is basically the reversing transformer described earlier. Five or six turns of No. 24 twisted wire on a T50-10 core will do at vhf/uhf. For a full gallon 3 to 30 mhz balun, bifilar wind ten turns (do not twist) of No. 14 wire on a T200-2 core.

Now, let's look at the Magic T as a power splitter. If power is supplied to port 3, it is divided equally between ports 1 and 2. The output signals at 1 and 2 have the same amplitude and phase. Assuming that ports 1 and 2 are terminated equally, there will be no signal or power output from port 4. If there is some mismatch at 1 and 2, some power will be delivered to port 4, which can be dissipated in a terminating load at port 4.

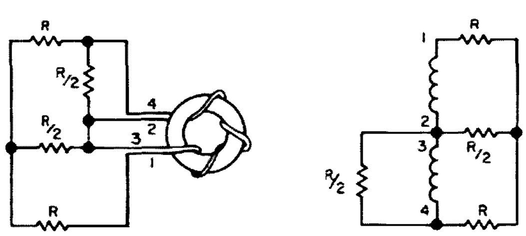

Fig. 1E. Basic hybrid or toroid Magic T. This transformer is similar to the 4:1 impedance transformer, but note that the leads are connected differently. Also, there is only 2:1 impedance ratio between 1 and 3 and 4 and 3. This is the basic device from which the power summer/divider is derived.

Signals can also be applied to port 4, in which case they again split equally between ports 1 and 2, but they are 180 degrees out

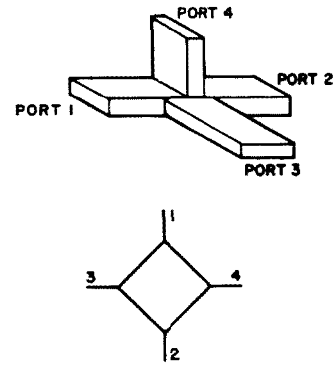

Fig. 2. Waveguide Magic T with a diagram representation.

of phase. This connection could be used for push-pull operation. The operation is just the opposite when the Magic T is used as a power combiner. If a signal is applied to port 1 and another signal at port 2, the output at port 3 will be the sum of signals at 1 and 2, and the output at port 4 will be the difference or zero. For push-pull operation, the output would be taken from port 4 where the out of phase signals would again combine in phase.

Fig. 3. General form of a hybrid.

While on the general subject of hybrids, another interesting configuration that has been used quite extensively at microwave frequencies will be covered. It's called a ring hybrid or ratrace. See Fig. 4A. Basically the ratrace consists of 1½ wavelengths of transmission line with taps as shown. The port numbers correspond to the waveguide Magic T, and it functions the same way as a power splitter and power combiner. At 450 mhz and above, it would be convenient to make the ratrace in printed circuit form; however at lower frequencies the size of the circle will become too big to handle conveniently. But, the ratrace can be made in lumped constant form, as described by R. M. Kurzrick, S. J. Mehlman, and A. Newton,[2] as shown in Fig. 4B with equations. This is a relatively narrow band device and should be designed for the center of a band. Using slug tuned forms, these devices can be made to function in the hf bands or at vhf with air core coils.

Toroid Core Magic T

The toroid core Magic T is essentially a

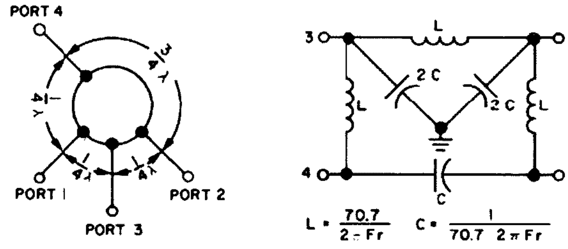

FIG. 4A FIG. 4B

Fig. 4. Ring hybrid or ratrace. 4A can be made in printed circuit form at high frequencies. Lumped elements can be used at lower frequencies as shown in 4B which is the Pi equivalent of the ring.

ferrite loaded transmission line and is illustrated as such in **Fig. 5A**. The line lengths between points 1 and 2 and 3 and 4 represent the bifilar wound coils wound on the core as shown in the basic hybrid of **Fig. 1**. However, the practical toroid Magic T for transmitter coupling use is the one described here, because it shows the proper termination for port 4. The winding is the same as shown earlier. **Fig. 5B** shows how these windings are cross-coupled to make a four port Magic T. Bear in mind that there is a 2:1 impedance ratio between ports 1 and 2 and 3, and that when used as a power divider or summer, port 4 is terminated in a resistor of twice the resistance at ports 1 and 2.

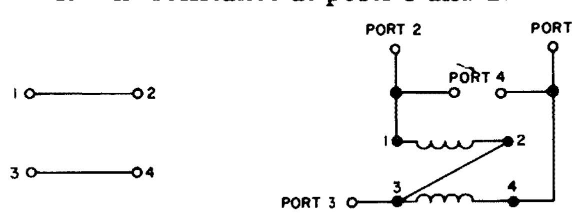

FIG. 5A FIG. 5B

Fig. 5. Toroid core Magic T. This is the configuration that is used at the input of a parallel transistor power amplifier to divide the power and isolate the transistors, and at the output to sum the power. For broad band vhf uses, five or six turns of twisted No. 24 wire on a T50-10 core is a good start. Twist the wire about ten turns per inch.

Here's hoping that you've found your way out of the ratrace because there is one more useful power summer/divider. It's shown in **Fig. 6** and it is useful because it has a 1:1 impedance ratio which may be needed when you have the desired impedances and don't want to do any additional transforming. This device can be economical because it can be wound on high value resistor coil forms. However, it would be preferable to use toroid forms to keep losses to a minimum and to minimize the number of turns of wire.

Using the Magic T

The Magic T has been suggested by several authors as a means of connecting *rf* power transistors to get more power output to defeat the problems encountered when transistors are paralleled. The most recent article by James A. Benjamin[3] describes the

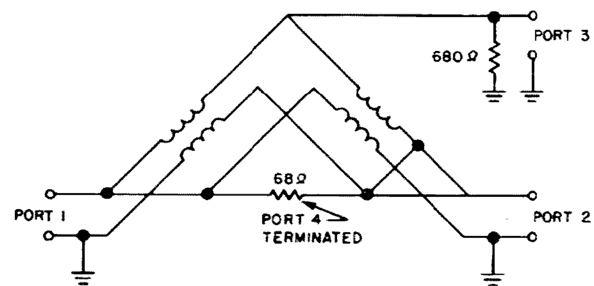

Fig. 6. Low-cost power summer/divider. Coils can be wound on 1 meg ¼ watt resistors. One device built for a special application had four turns of No. 26 wire twisted togethed on each form. This device had excellent characteristics over a frequency range that covered 350 to 550 mhz. To lower the frequency, simply add a few more turns. Also, better results (lower losses) can be had by using two toroid forms such as the T50-10.

technique very well. In fact, he describes a broadband *rf* power amplifier that covers a band from 200 to 400 mhz and it does not use any tuned circuits. Some of the material from this article is presented here in hopes of spurring interest in using these same techniques to develop amplifiers that can cover the range from 50 through 150 mhz. A general picture of how the Magic T is used is shown in **Fig. 7**. The method shown provides

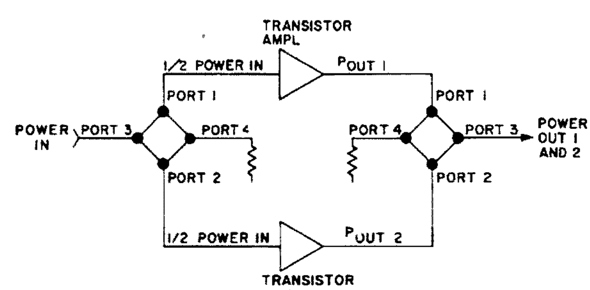

Fig. 7. Block diagram illustrating how the Magic T at the input isolates transistor amplifiers 1 and 2 from each other and from the driver. This permits them to operate independently. Their outputs are added in another Magic T at the output.

parallel type operation. If port 3 and 4 are interchanged at both the input and output, push-pull operation is achieved. This method of connection might be preferable since even

harmonics will appear in phase at the terminated port and be dissipated in the resistor.

This technique is not limited to driving just two amplifiers but can be expanded by powers of 2 to the limit to your dollars. What I'm saying is that you are not stuck with rebuilding from the ground up if you want to go to more power. But, keep in mind that the driver must be able to supply enough power to drive the whole mess. See **Fig. 8.**

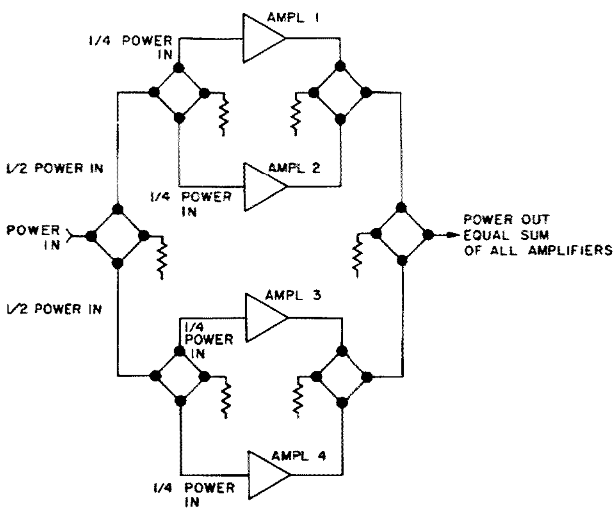

Fig. 8. Diagram representation of how four amplifiers can be combined to get more power output. The next step is eight amplifiers, then sixteen, etc.

The 200 to 400 mhz amplifier described by Benjamin is shown in **Fig. 9A.** Magic T (on toroid cores) is used at the input to divide the input power and isolate the transistors, and at the output to combine the power from the two transistors. Note that there are several other transformers in both the base and collector circuits. These are the 4:1 impedance transformers of **Fig. 1B.** Also note that there are no resonant circuits, hence with broadband transformers and the proper transistors a similar amplifier could be used to cover a wide range of frequencies: for example, 50 to 144 mhz or even 3 to 30 mhz. Bear in mind, that transistor gain decreases at higher frequencies so you are going to get a decreasing power output as frequency goes up. But this is a fact of life and you would get less power with an amplifier designed specifically for that higher frequency.

In the output, the load that the transistor must work into to develop the required power output is given by $R = \frac{V_{CC}^2}{2\ P}$

For the amplifier in **Fig. 9**, Vcc is in the range of 12 volts and the expected power output is 2.5 watts per transistor. Therefore, R is in the range of 25 ohms.

The 4:1 transformers T6 and T7 in the collector circuit step this 25 ohms up to 100 ohms which, in turn, is stepped down by the Magic T to 50 ohms. So, no other impedance matching is needed to feed a 50-ohm transmission line and antenna.

The 200-ohm resistor terminates port 4, and its value is twice the impedance at the two input ports. Actually, this resistor should be capable of dissipating the total power in case of problems. However, in practical operation, this resistor is dissipating very little power. So, you could get by with a ½ or 1 watt resistor. After all, if it does go, it's easy to replace. The devices used in the circuit are ITT Semiconductor 3TE467s which are experimental devices, however other high frequency transistors like the 2N3866, 2N3553, or 2N3924 could be used. The input impedance of the 3TE467 is 2 ohms which accounts for the double transformers T2, T3, and T4, T5 in the base circuits of the transistors. These 4:1 transformers step up the 2-ohm transistor input impedance to 32 ohms which is then stepped down by T1 to 16 ohms. The driver impedance will be higher than this, so you could probably use link coupling to step this up to the driver impedance. Most of the devices mentioned above require drive powers in the 100 to 200 mW range. So a 5

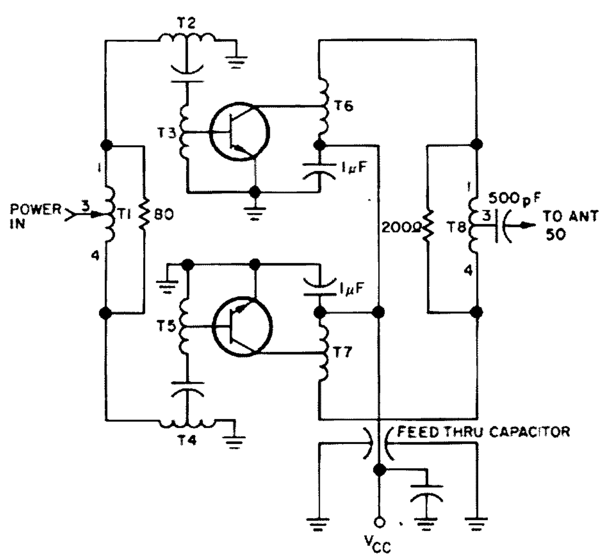

Fig. 9. Broadband vhf amplifier uses no tank circuits. T1 and T8 are the Magic T described in Fig. 5B. T2, 3, 4, 5, 6, and 7 are the 4:1 impedance transformers of Fig. 1B.

to 600 mw driver will do. The extra power is to take care of transformer losses.

Bear in mind that the input impedances of devices vary. These are specified on the data sheet. For example the parallel input resistance for the 2N3924 is about 11 ohms at 50 mhz. So, if you experiment with this device, you may only want to use one step up transformer in the base.

Benjamin used the blocking capacitor between the two base transformers to equalize power output over the desired frequency range. That is, he chose the capacitor value to reduce power output at low frequencies to compensate for the higher transistor gain. This capacitor can be made to resonate with the transistor's LCR input characteristic on an experimental basis. Value will depend on frequency and transistor. Try a capacitor in the 1000 pf range as a start. Then substitute for maximum power output. Benjamin's design yielded reasonable impedance levels. Other designs may not. In these cases, the usual Pi, L, or tuned matching network can be used with the Magic T. Tuned circuits destroy the broadband feature, but they may be necessary for matching or for harmonic attenuation. Lots of luck with your experimenting.

. . . Darrell Thorpe

The toroid cores mentioned are available from: Circuit Specialists Co., P. O. Box 3047, Scottsdale, Arizona 85257. The T50-10 or T50-2 cores are (2) for 1.00 with No. 24 wire. The T-200 core, for Kw blauns, is $2.00 each with No. 14 wire.

Please include 25 cents for shipping with each order.

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Uncle Will and News from the Poudre Valley

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Ft. Collins, Colorado 80521

Dere Mister Editer:

Our Radio Club president reported he had been hamming amongst his ham friends ever night for a week and had a sore throat from hollering loud enugh to get heerd above his friends' TV sets. The friends' TV sets kept trippin the VOX makin matters even wurse as then they doubled bout ever other transmission. Our presedent said he wasn't even shore if some of the members would recollect he was even on the air without rechecking their log, if they kept one they could read! But the good presedent admitted TV was here to stay, said he even was larning to live with it if Ben's TV could just keep it running.

We had some bad news lately with our presedent's doctor telling him he might be gettin ulcers. The doctor order him to take it easy and let the other "ham" members do more work. Our presedent sid all his members was working now, 4 was working *for* him and 30 was workin *again* him, but then they was ALL workin!

He also said him and a couple other members got out the records fer the last year to see how the work load was runnin and the record wasn't good. They showed that 15% was pushin the wagon and 85% was just ridin. It was that 85% he allowed, that mite be givin him ulcers. One of the other workin members looked at the things he had done and said he didin have no ulcers hisself but he was gettin tired blood and, after all that, he figgered he was just POOPED from PUSHIN!

Our presedent said him and the secretary decided to make another little survey to find out what that 90% of the inactive Radio Club "hams" was doing. They found 40% was pouting over somethin that had took place at an old meetin. These members couldn't recollect just what it was but they claimed they was so upset they couldn't get over it!

Another 8% was settin at their receiver keepin score on how many times some AM station would qrm them with carrier. One fellow, they reported, was keepin score by cutting notches in his mike. Twice his knife slipped and he cut through his mike cord which only made him madder. Once he waited an hour for a station to identify but then he found out the carrier was from his 100 hz calibraytor which he had left on by mistake.

About 22% was figgerin out how to get rid of ARRL. They didn't have nothin special again ARRL but getting rid of anything like that was jist one of there aims in life. Now ever club has some of them kind! It sure takes a wise ham to know when he is fightin for a principle or merely defending his prejedice.

The other 20% of the inactive Radio Club group was just being gud listeners. They wood never think of hookin up there transmitter and participating. They just sat and listened to the others.

Our Radio Club bunch sure haven't done too well lately on new gear. Out of the duzens I talked too there warn't one that has recently got some new TVI gear. I always say,

The ham who has everything
Must need ONE MORE, no doubt,
A gadget that will explain to his wife
The "junk" he cannot live without!

After comin thru anouther holiday season it seems as if we measure the *joy* of our holidays by the number that gits killed on the highways and ever year it gets more *joyful.* So please try to *drive careful* with your *car full!* I'll promise to be especial careful while driving and hammin. These summer holidays can be *murder.*

Lookin back at what I rote, I can tell you I ain't got the litterary talent nor them easy flowin werds of them writers who usually have articles in your magazine. I shore hope that you git the main message of this here letter though. So, anytime, Mr. Editer, you want to know the state of the werld and how things is goin in the ham werld, just git me the werd and I'll poll the Radio Club delegation. I shore don't rite nice, nor good, nor purty. I'm certingly not the best in the West but I am the cheapest you got.

"73" from the foot of the Rockies,
Old Uncle Will
KØDVI

Jim Ashe

Basic Soldering Outfit

Confused by all those ads and catalog entries offering soldering gear, guns, and irons? I've been soldering in electronics for the past twenty years, yet when I was researching this article I found a slightly disconcerting variety of choices. So if you think it's hard to choose the best tools for your work you must have lots of company.

The Basic Outfit

Over those twenty years I've tried a variety of gear, looking for some optimum collection. I have even experimented with soldering guns, which I do not recommend to anybody. Too clumsy and uncontrollable. By degrees I finally evolved what seems to be the best all-round soldering outfit, and the gear I'm describing here has all been busy in my private lab for something over the past five years. It's not the cheapest you could buy, but I believe it's the best investment.

Here's what it should cost you to duplicate this set, if you purchase all new materials.

Variac box, home made	$12.00
Ungar type 776 handle	1.43
Ungar type 4033 48 watt plated chisel tip	2.83
Ungar type 1237 38 watt thread-on tip	1.86
Ungar type PL-111 plated tip slightly modified	.70
Some good solder (1 pound)	3.00

Total investment in the order of $22.00. Not bad, considering everything except the solder will last many years, and the Variac box will have other uses.

The Variac Box

As the most expensive item in the system, perhaps the Variac box deserves attention first. And it is the part that makes the rest of the system thoroughly practical. The Ungar irons tend to run too hot if they are used while connected directly to the power lines, but with the added Variac box they can be toned down to just the right temperature for delicate work, or overvolted for heavy-duty cable or chassis soldering.

A 4 x 5 x 6 inch Minibox contains the circuit shown in **Fig. 1**. The Variac is the most expensive component, and I discovered Allied is selling some tiny 1-ampere Ohmite variable transformers for $8.00. And Lafayette's catalog lists a comparable transformer priced at $9.00, rated at 1.25 amps. Both prices are below the cost of my 1.75 ampere Superior transformer, and either will do a fine job of putting out the 0.5 amps or so required by Ungar's huskiest tip.

A neon pilot lamp in the input circuit avoids difficulties with indicating the variable output voltage, and the double-pole power switch is standard practice in all the gear I build. It disconnects *both* sides of the power line, an elementary safety precaution. I placed the fuse in the *output* side of the circuit because this is where the current may be greatest. I could be drawing one-quarter ampere input current to develop four amperes output current at seven volts or so, which could spoil a few turns of Variac winding at the low-voltage end. Of course that ruins the rest of the Variac, an undesirable accident completely preventable by a properly placed fuse.

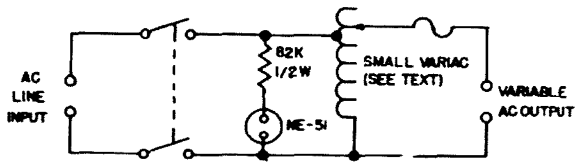


Fig. 1. Schematic of the Variac box. This circuit is a handy one to have on the bench. Be careful to respect the Variac's current as well as power limitations.

If you are using the Variac box for some test rather than soldering work, remember there's a straight-through connection at one side of the power line, and an almost-direct connection to the other. A slightly better but more expensive arrangement would have included an isolation transformer.

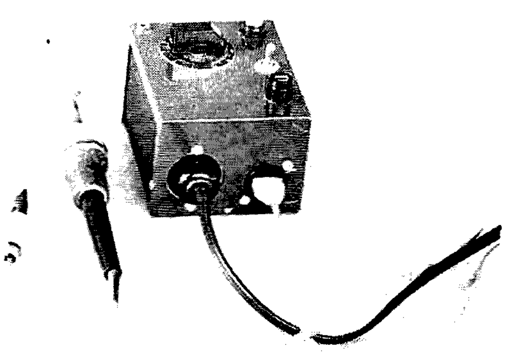
The husky ac chassis-mounted male plug appearing in the photo is going to come out one of these days. I'll replace it with a standard cheater-cord type tv connector. Everything else in my lab except a couple of instruments that require about 800 watts apiece (old vacuum-tube gear) now has these convenient cheater-cord connectors. It's nice to avoid carrying around all those cables when moving a piece of gear.

The interior layout is simple and straightforward. There's just enough room in the box for an uncluttered layout. The white wires go straight through from the input to output, and the black ones carry the circuit through the variable transformer.

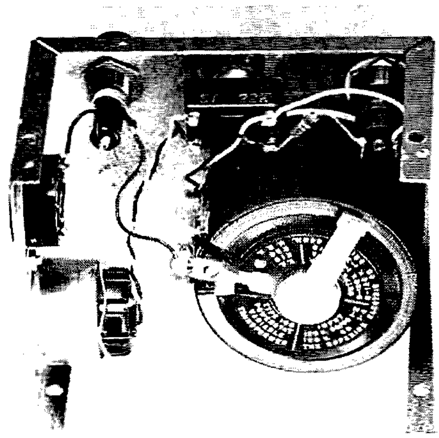
Before assembly, I cleaned the box and sprayed the upper part with dark green enamel, and the lower part with flat black. I used an inexpensive, fast-drying enamel that has proven remarkably long-lived.

The Ungar Hardware

Ungar's No. 776 handle is an evolved version of a simpler iron they started producing some time after WW2. I had one of those and liked it, although it tended to become quite hot, and the plastic gradually scorched black. Since then Ungar has licked those problems completely. The modern metal-shielded, cork-insulated handle is comfortable to use, cool, light, well-behaved and long-lived. Someday I'll have to try one of their newer varieties, but I have to admit to a tendency to get by with the thoroughly satisfactory and less expensive old-standby No. 776 handle.



The complete basic soldering outfit. Pretty simple, isn't it? Under $22 in all new parts should set you up with this, and it will last many years.

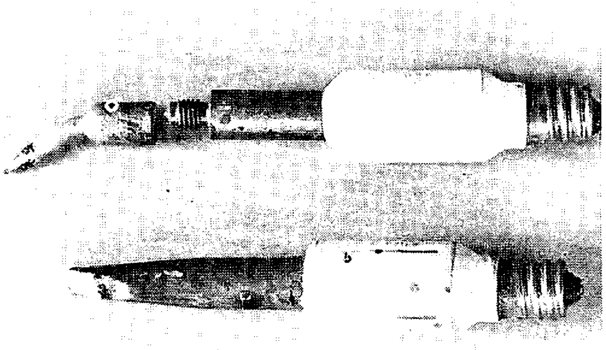


Parts layout inside the Variac box. Use plastic insulated solid wire.

Depending upon whatever job you have in mind, you simply screw the appropriate tip into the handle, like an electric lamp bulb. If you have a heavy job of soldering or are working on large vacuum-tube gear, the type 4033 48-watt tip is very appropriate. When connected directly to the power line this tip runs hot enough to burn the solder, but at a lower-voltage setting it is extremely well-behaved. Since it is silver and iron-plated it does not have to be filed down and tinned frequently, as I used to do with the old copper irons. In fact, you *never* go at this tip with a file. It will wear out in a few years if you can use it enough, and then you spend less than $3.00 for a replacement.

When you have a heavy chassis-soldering job to do, you use this tip. Let the iron warm normally to soldering temperature, and then turn the Variac to maximum voltage. In a minute or so the iron will start to give the impression of being very hot. Shortly after this you can start soldering, and there will be enough heat to do much heavier copper cables than you would expect, or good chassis work. I have even used this setting for aluminum soldering, with messy but usable results.

As soon as you are finished, let the iron cool down to normal temperature and finally turn it off. *Don't* leave it at the high-voltage setting any longer than necessary. Some of this sounds like rough treatment, but since the iron spends most of its working hours at relatively low temperatures it seems not to have life problems. The gradual warmup and cooloff I've recommended for overvolting may have something



The two basic tip assemblies. Both have been in business for a few years in my lab.

to do with it too. I've never had an Ungar tip fail, although a couple or three have come apart after accidental very rough treatment. These tips are rugged, but are not up to being dropped onto hard concrete floors.

For light-duty work, small vacuum-tube gear, and printed-circuit wiring, use the No. 1237 heating element with a PL-111 tip. This tip comes as a straight-line piece, and after you assemble it to the element bend it to an angle of 30 degrees or so to the long axis of the iron. Take the strain on the metal part of the heating element, and bend with a heavy pair of pliers. The angled arrangement is far more convenient for soldering. This tip, too, does not need to be filed down and retinned. And as with the No. 4033 chisel tip use the Variac box to control the operating temperature.

If you don't dismantle the tip from the heating element once or twice a week you may find it has bonded itself permanently in place. Since I might want to use another tip sometime, I store the heating element with its soldering tip removed.

Soldering Hints, and Applications

I won't repeat all the stuff you find in the books (which you ought to read) and I'd specially recommend *How to Build Electronic Equipment* by Johnson, Rider Publisher No. 286. But here are a few suggestions.

Don't have any acid core solder in your lab. Use good rosin core solder, but watch out for what you find in the shops and stores open to the public. For instance, a certain very large retailer sells rosin-core solder at a very economical price. Turns out it is 40/60 solder: 60% lead. You don't want that because its melting point is about 100 degrees F. higher than the melting point of good solder.

Looking at any reel or package of solder, you should find an entry typically 50/50, maybe 60/40 or even 63/37. These are percentages of tin and lead, the tin percentage given first. Solder with more tin melts at a lower temperature, which is preferable. It costs more because tin is more expensive than lead. I use 60/40 solder for most work, which melts at about 370 degrees F., and always purchase the finer-gauge Kester or Ersin electronic solders.

When soldering, according to the books, you let the iron heat the work and then melt the solder directly on to the work. I think this advice is a bit misleading. Typically, the work is warmed with heat carried over by the *rosin flux*. Since the work is not yet warm and heats very slowly by conducted heat from the iron, there must be some flux free on the iron tip to carry the heat to the work. Next time you're soldering watch closely and you will see this. When I am soldering I place the iron against the work, and if the work does not heat very rapidly I touch the rosin-core solder to the *iron*. The fluxing causes the work to heat rapidly and as soon as I see the joint becoming hot enough to accept solder from the iron I then add a bit of solder to the work.

The iron should be warm enough that soldering proceeds quite rapidly, but not so hot the solder burns and free flux on the tip develops rapidly into crisp black flakes. Try experimental soldering at various settings and you'll soon discover which ones are best.

I haven't found anything better than heavy brown paper towels for cleaning my iron. It smells odd, but works great, and although the iron is quite hot there is no fire hazard. I start at the handle end of the tip and wipe right down to the end when necessary. Ungar and others offer special pads for this cleaning. I'm going to try one of these someday, but I've got by with the brown paper towels for some time now.

When you have some plastics or brown polyethylene work to do, use the heavier No. 4033 tip. It should not be so warm the solder softens. Once you're done with the plastics work (sealing a twin-lead dipole to its transmission line, for instance), turn up the Variac to a normal soldering setting and as soon as the solder softens start wiping the tip with the brown paper towel. You'll get strong sharp plastic odors, but the tip will clean up nicely. Apply fresh solder and you're ready for normal work again.

. . . Jim Ashe

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Light Naturally Runs Down

It is time, not Doppler recession, that causes the famous red shift of the spectrum of all the distant stellar and galactic objects.

The application of this principle to electronic communication may have a great effect on the high-speed digital transmission of computer data through space, here and elsewhere.

Even today 600,000,000 bits per second can be achieved, which could take care of several computers "talking" to each other at once.

The sentence in the Scientific American that triggered the writing of this article.

On page 58, third column, February, 1969, we find the following, written by V. L. Ginsberg, of the U. S. S. R., speaking of quasars. ". . . not one of the approximately 1000 Quasars so far observed shows a shift to the ultra-violet that would indicate motion towards us."

Many times I have read about the red shift of light from distant sources, from which the "Big Bang" theory was evolved. According to this one, every island universe, galaxy, star, quasar, pulsar, what-have-you, is receding, each from the other, including us. It is a possibility, perhaps, but one which never appealed to me at all. Now of course Doppler shift does most certainly exist, but there is another possible explanation of this red shift that is found to increase in direct proportion to the distance of the source from us.

This is the theme and purpose of this article, a possible explanation of how light can slow down (not in velocity, although it might do that too, over a long period of time) and increase its wavelength. This slowing down, once again, concerns its rotation as a three dimensional blip of energy, whose shape is yet to be determined. Maybe a flat spiral?

Introduction and philosophy of this article

There is a possible explanation of how light can "run down", which is detailed below. It also shows why these same light waves act like particles. They have to; they're shaped like particles! As the title suggests, light naturally runs down, not in velocity, not in frequency (it hasn't got any!) but in rotation, which causes the size, and therefore the wavelength, to increase.

I can imagine, so far, no mechanism whereby it should speed up, but have for years been working on one whereby it may slow down. Not in its travel through space, but in its "rotation," which is accompanied by an increase in wavelength. I am repeating here for emphasis. It just takes a little more *time,* measured in light years, and does not require any Doppler caused by motion. Doppler shift can occur also, of course, but the large red shift found on all distant objects had nothing to do with Doppler, which is another subject entirely.

In this article we will bring to bear on the subject many ideas and facts which, after study, will be seen to be very pertinent. The application to "radio" transmission will also become apparent.

Waveshape

Anyone having experience with fast timing in electronics during the past thirty

or so years knows the importance of the shape of waves, even if only in two dimensions. Pursuing this a little further we come to, or rather approach, the "infinitely short pulse". This, as the old German professor used to say, "Ve don't got", but we can get pretty close, as will be seen.

Plunging right into the intriguing world of electromagnetic pulses which are extremely short in time, **Fig. 1** shows a "multi-barrelled" graph of certain parameters which will help you break away from the much too narrow concept of only sine waves and frequency, useful as they have been and may still be, for certain special cases, and lead you into another more generalized world where the three-dimensional shape of a wave is very important.

After all, how can a single event have a "frequency"? Fourier said that any pulse can be resolved into its component frequencies. In the sense that "it is possible to divide time into smaller lots of time" this is true, but blind following of his work, great as it was, with "sine waves only" has unfortunately served to obscure equally important possibilities of work with "non-sine-waves," as will be shown. This work covers the entire left side of **Fig. 1**.

A single event, by definition, cannot have a "frequency". If you attempt to chop it up into "component frequencies," you are not dealing with the original event, and you are certainly practising obscurantism, even if unwittingly. If you grind a stone into molecules it no longer falls, but drifts away on the breeze. It is, of course, no longer a stone and doesn't act like one. It cannot truly be said to be "Just a matter of size or degree."

Single electromagnetic waves are present all over the world as lightning, etc. Such single waves can bounce back and forth in space or on conductors or filters and *acquire* a frequency by so doing, but that is not necessarily *its* frequency!

The action of filters has been dealt with at great length through the years, but please do not neglect the preceding sentence.

Features Shown On **Graph No. 1**

1. The entire left side of this graph is still mainly unused by engineers today. It has however had immense usage by "Nature" for millions of years. This is the region of heat and light waves. The time duration of the photon has not yet been directly measured, other than to say that it can be obtained using the velocity C and the wavelength of light.
2. It is interesting to note that the work with Lasers moves to the right on the graph, increasing the "time on the air", and the frequency precision. Naturally, hasn't everybody been brought up on sine waves?
3. Even with today's crude methods, information can be transmitted through space at a rate of about 600,000,000 bits per second, by operating on the left side of this graph.
4. The need for "frequency bandwidth" of course disappears on the left side of this graph as we enter the domain where time reigns supreme. Each event, photon, single electromagnetic pulse, digital bit, or what have you, is a single event. There is no need, nor any utility, in considering frequency while on the far left of this region.

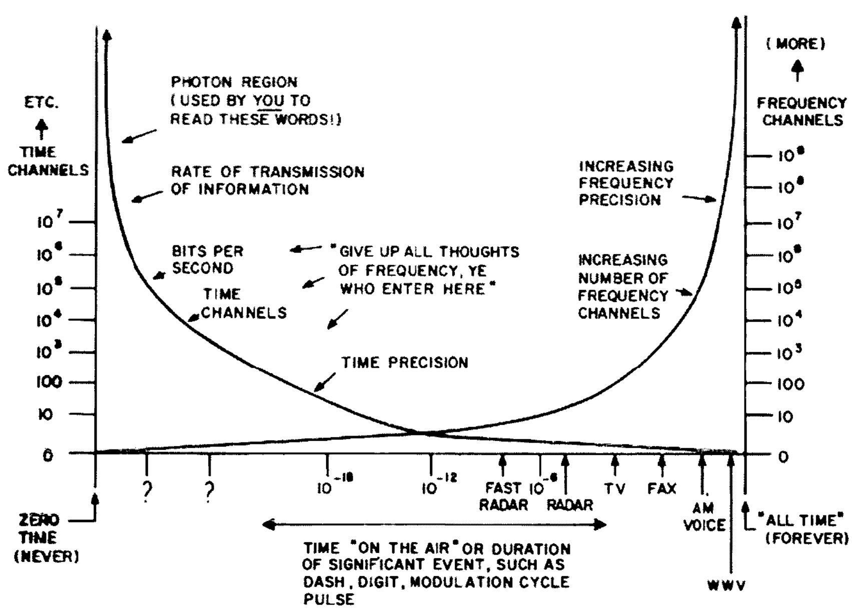


Fig. 1. Graph No. 1.

5. By the following means "noise" can be reduced in time channels in the same fashion as is done with frequency channels. Any one time channel is "open" for a very small amount of time. In a way this can be considered the "reciprocal of integration," and just as useful.

6. One example of the use of this graph; Use two transmitters, one operating on the far right of the graph as an excellent clock and only as a clock, the other on the left side as the "bit sender". Transmitter A sends precision timing using a highly stable crystal controlled microwave signal on, for example, 1,000 megacycles. Transmitter B sends one bit every nanosecond, timed by A's clock. At the distant station, Receiver A sets up the clock based on transmitter A. Receiver B is turned on by clock A, and receives the digital information through the nanosecond gates.

You can't say much that is meaningful in terms of frequency about a single wave of this nature, except that it "spreads from here to there" in frequency. Belaboring the point because of most reader's training in Fourier's analysis, with, I believe, no corresponding studies of really short pulses, like 10 to the minus 18th, getting into the photon region, to say it has a "bandwidth", which to most people means frequency bandwidth, doesn't really say very much about the wave as yet.

However, if you speak in terms of time bandwidth and time filters (narrow time gates), and use something handier than the second which is very "gross" for this work you can begin to define these waves, (photons, small, large, and giant) with great precision. You can see here, of course, the action of Heisenberg's famous uncertainty principle working right in front of your eyes. The closer you measure a wave in frequency, the more time it takes. The closer you measure it in time, the more frequency it takes. Real simple, right?

It doesn't matter very much in time whether you listen to WWV for two hours or for three, and it doesn't matter very much in frequency bandwidth whether you say 20 GHz or 30 GHz.

This relation is trying to tell you something, if you will open your mind a little. As a clue the photon is caused by an electron changing its energy level. Well, didn't we agree above that for a conductor (obviously full of electrons) to radiate you touch it with a battery?

This whole subject region is of course way out on the left side of graph no. 1, and as such is strictly in the time domain. Just forget about frequency while you're over there.

It just happened that someone (I think perhaps Fessenden, but Lodge had some claims way back nearly one hundred years ago), first put an inductance in the line, or across it, thus setting up resonance. This allowed the use of two stations at the same time in the same town, which was most ususual for those days. And so we inherited frequency separation for our multitude of broadcasters. Time division could have given us an equal number of stations but no doubt an equal number of problems; all different!

All of this is leading up to the third dimensions of the photon, the one which causes it to "look" and "act" like a particle. At times, that is!

Oscillators are not needed for the generation of electromagnetic waves

Light and radio waves (that is once again electromagnetic waves), are fundamentally generated by a change in voltage, or current, or both. Because, although a battery may just sit there with positive voltage on one end and negative voltage on the other, no event really occurs until at least one electron is moved; then you have a current. If a conducting sphere, in space, is touched by one side of a battery and then by the other side, radiation will take place and travel outward at the velocity "C". It will do the same if touched by an electron and then by a "hole".

A copper sphere radiates some eighty percent of an electrical energy distribution on its surface in the first half wavelength. It is the world's fastest radiator, has the worst

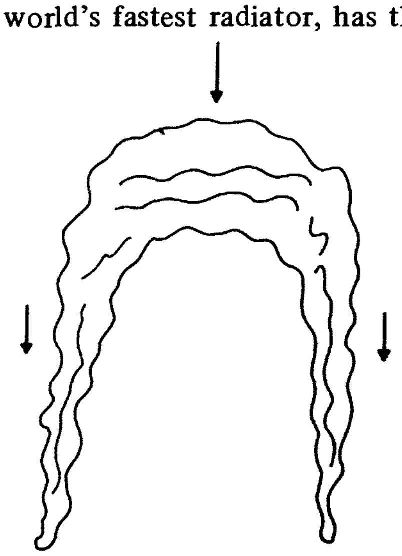


Fig. 2. Vortex wave grazing on water.

"Q" known, and if properly treated, can serve to radiate and transmit right now, even with crude methods, some 600,000,000 bits per second of information through large amounts of space every second. Takes care of any information several big computers can handle simultaneously, too!

We are getting warm now, on the basic subject matter. We just need to find a small enough sphere to radiate those small light wave pulses. What's that you say? The molecule or the atom, or the nucleus? Sounds possible. We will need a real wave, but one that has a *3D shape* like a particle.

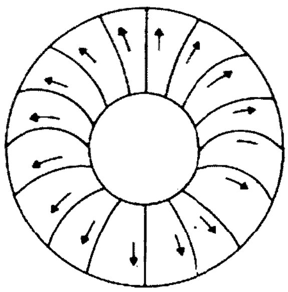
A wave already exists which is constricted in three dimensions, even four if you count time also.

But, you say, "all waves spread out as they travel". That's what you've been taught, so that's what you believe. Who are you to question your "betters", the Great Savants who proved that light consisted of waves, and the other greats, like Einstein, Planck, and Bohr, to name a few, who proceeded to prove light was composed of particles? Now just a minute, aren't the above contradictory? Yes, of course, and then they were also combined (partially) by the Nobel prize winner Prince De Broglie.

And so it has gone on, perhaps needlessly, for there has been in existence for untold decades, a type of wave that *has* the *shape* of a *particle*. It even has a name! The vortex wave. True, it is a sound, or shock, wave, and sound waves require a "substance" in which to propagate, such as air, water, or a solid. But supposing and here comes a great big supposition, we simply investigate this sound wave as a starting model only, for an electromagnetic wave to work on later? Don't forget sound waves are also taught as "radiating in all directions".

My first meeting with the vortex wave

In my youth we lived on an island in Maine every summer and I used to go a mile and a half over to the mainland every day to get the mail. On clear calm days with a slight swell running our one-lung Captains boat pow-powing away, the fourteen minute trip was a great pleasure, with time to relax and watch things that were happening. One of these was the exhaust from the old five horsepower make-and-break engine. It fired several times a second and the blast was released through the exhaust vent, on out through the muffler (which I believe had no "insides" left), and on out through the two inch pipe, positioned horizontally out over



DIRECTION OF TRAVEL
OF WAVE IS OUT OF THE
PAPER.

Fig. 3. Doughnut wave phase diagram.

the water. When the 22 foot dory rolled slightly at an angle just under the horizontal, a peculiar phenomenon occurred. An impression was created on the still surface of the water anywhere from 25 to 100 feet out, with every exhaust blast.

This impression, shown in Fig. 2, occurred with a slight delay which I associated with a sound wave. I found out later it was the mark a vortex wave makes on hitting the water at a slight grazing angle, the doughnut shaped wave standing up vertically as it hit the water.

Later vortex waves

Working as a member of the Technical Staff, Bell Telephone Laboratories in New York in the late forties, was a considerable inspiration. One which encouraged me to pursue my studies of fundamentals, and helped to make me think deeply about electromagnetic waves in particular, even though H. S. Black, inventor of the feedback amplifier, said to me, "You must think, write, and talk rigorously here at Bell".

These studies led me to wonder more and more about the famous controversy over the particle-wave question, and to investigate the generation and propagation of the vortex sound wave as a class of non-spreading waves that perhaps could be used to imagine an electromagnetic wave of similar character and action.

Generation and mechanism of the vortex sound wave

Boxes with small round holes in front were pounded on the back with a hammer and these indeed generated nice vortex waves. Satellites, space ships, and other things entering our atmosphere also make nice ones. They have a name too; *"sonic boom"*.

These boxes were filled at times with smoke, and very fast-travelling rings were blown, as well as quite slow ones. Note that shock waves can travel at all kinds of speeds,

such as the Bikini shock wave was that travelled at *many* Mach numbers. With these smoke rings, the mechanism of the ring, its slowing down in frequency (rotation) as it travelled, the rotation of the smoke particles following the wave motion around the doughnut shaped ring, their rotational phase-change of 360 degrees around the ring, and their generation by the round exit hole of the box could be seen by the eye. Each particle rotated, travelled around the cross-section, and the ring as a whole travelled forward. Perhaps, if you are old enough, you remember the Flettner Rotor-Sail Ship? A cylinder, or sphere in a slipstream (gas or water) which, perhaps due to its own motion, or that of the medium, or both, is subject to a force at a large angle to the direction of travel. This causes each particle to move sideways, as it travels ahead, making a spiral relative to the previously undisturbed medium; air in this case.

The doughnut shaped ring of smoke has a fascinating stationary metallic toy equivalent known as a "Slinky", which is a flat spring that can be curled around and have its ends joined. Then if you rotate the metal around the cross-section you will see the "phase" go 180 degrees out opposite your fingers and magically come back in phase again. See Fig. 3, which illustrates both the Slinky and the smoke ring.

Slowing down in rotation

Naturally, the smoke ring particles slow down as they travel through the molecules of air, as does the force-wave associated with these particles. Also, the cross-section gets bigger, the doughnut gets bigger and its forward travel slows down. Now, of course, the force-wave itself is the generator, and the particles were only put there to render the wave visible, which they do nicely.

The electromagnetic vortex wave

The great Maxwell said that there was a "medium" for electromagnetic waves. He confidently assumed other physicists ("Natural Philosophers") would discover this. But, as you know, they did not do so, and, one hundred years being quite a time to wait, it became unfashionable to talk about this "aether." After all, if you were unable to find it, even though you know a wave has to have a medium, and being a professor you *had* to teach something, the only thing you could do was to make it an "out" thing and stop talking about it. Maybe then people would stop trying to make you admit you didn't know. You can also fall back on the excuse that the only thing needed is to be able to measure it. Pretty slim pickin's, I think.

Now let us suppose that the light waves, or quanta, as they are also called on alternate days of the Advanced Studies Group's week, are actually something like the vortex wave. They can be generated by a phase delay mechanism, but, before that, they cannot be other than a single event. This fits fine. The non-phase-coherence of *unfiltered natural* light waves (sunlight for example), is a fact.

The single wave (the shock wave as generated in the box), allows the wave to fold on itself, as can be seen best in a glass smoke ring box, so that the doughnut shape is formed, travelling forward, with everything nicely in phase in that *single* little energy-packet-wave itself. If you try to make the vortex wave out of a continuous wave motion you will fail.

Still, supposing that we succeed in making, by means which I propose to use later, a somewhat similar type of electromagnetic wave. What will we have? It probably will travel at the velocity C, at least at first, unlike the vortex wave which can go at Mach N when first generated by a hydrogen bomb.

Due to an entirely *different* medium being used, not only in our atmosphere and in Space, but pervading even the atom itself and probably the nucleus too, our electromagnetic vortex wave will rotate (spin?) (1/2 spin?) at a rate which will be very fast, dependent on its size, like gamma rays, X-rays, blue light, red light, etc., as this size increases.

This length may be seen to be the size of the "doughnut" or whatever shape it may turn out to have, (perhaps a varying one?) as it goes by or impinges on something, such as a photo-electric surface, for example, at the velocity C. Although it may not be shaped like a doughnut at all, it *will* be confined in three dimensions.

A wave of this type also needs quite a special type of detector, and would quite naturally need to be small in order to knock one photo-electron out of an atom. I have imagined a detector for this type of wave (the giant photon one) but it doesn't look like an atom. Or does it? What does an atom look like anyway? It was Lord Rutherford I think who said, "You will never see an atom". Maybe so. And then again, maybe not so!

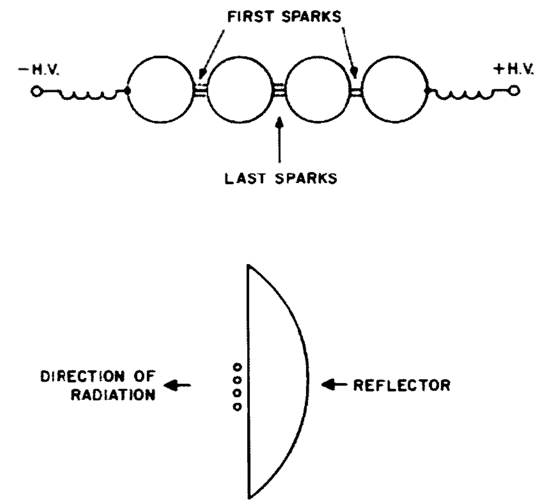


Fig. 4. One of Marconi's first radio transmitters.

The light wave gets *bigger* as *time* goes by

As the photon-lightwave-particle doughnut wave travels through space and through the medium which after all *must* be there in some form or other, even though the mind of man has not yet actually "put his hand on it", it may well act like the vortex wave model in several respects and slow down its rotation (or whatever it is doing to keep itself together) over a large number of years at least, getting bigger as a result of that medium having *some* friction, however small this may be.

This will of course increase its wavelength, making a "red shift." Don't forget that it is a unique, single wave, or event, and therefore not having any frequency, as far as a continuous collection of waves following each other is concerned.

As we go by here in sort of a rush (after all this is an article, not a book) the particle-wave controversy may be cleared up once and for all.

Time division versus frequency division and the uncertainty principle, as they apply to the photon and radio waves.

In our present era, frequency division reigns almost supreme but it was not always so! Marconi's first transmitter was the "four-ball" type, which was that of his teacher, Professor Rhigi, who followed Hertz' model, as shown in Fig. 4.

In this system the two outer balls charged up, then discharged by spark, over to the two inner balls which then proceeded to generate a spark between themselves, and the two outer balls then disconnected themselves automatically by quenching their sparks as the voltage dropped.

Note the absence of inductance, other than the copper surface of the spheres themselves, and remember that a copper sphere radiates some 80% of its energy in the first half wavelength. There is not much point in calling it half a cycle as the event is almost over by then. Fig. 5 shows an approximation of the waveshape, as drawn by some of those lads in the last century, one of them being Sir Oliver Lodge, who was quite aware of the time duration involved which was a few picoseconds (10 to the minus 12th sec.) even in the absence of such things as Tektronix or H. P. scopes!

Being considerably versed in optics, they measured it by the use of interferometers and, of course, in a wave as shown, there is little to interfere with! But the interferometer will, and did, draw the waveshape nicely for them, even if only in two dimensions.

Into the realm of pure conjecture

The Electron.

Let's really delve into things a little. I have never read anything about the shape of an electron, other than it is not known. Even though some learned types of people say that, "it is useless to inquire into such a thing," this still doesn't satisfy me. It has mass, probably of electronium, and can thus stand still, which is impossible for a photon. It is the basic unit of electricity, at least so far as is known today. It still suffers tremendous confusion with something called "current" because our learning and teaching suffer even more from tradition and authority. The chief engineer of a large and prosperous, tube plant, which shall be nameless, was, due to this "training", unable to think of the difference between the electron flow and wave flow in and around the very good (but limited) tubes made by his technicians.

Both Faraday and Maxwell studied and wrote, in quite a different style of course, about something they called "displacement current", which left the conducting metal and jumped across the intervening space. This "thing" is of course electromagnetic energy and travels at the speed of light. I expect it would, being emitted in quantum style and thus made up of photons!

But the slow-poke electrons, according to Einstein, and everybody else too, never reach the speed of light. Indeed, in these tubes they suffer badly from transit time. Not any more so of course, than those of any other good manufacturer.

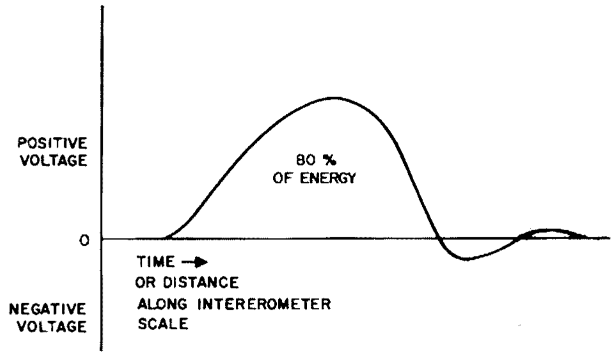


Fig. 5. Waveshape of radiation from a conducting sphere.

Speed of the photon

Now the photon does not suffer much from lack of speed on Earth but it does a little when you talk to someone on the Moon, and a great deal when the day comes you would like to talk to someone many light years away. The photon travels at a velocity known as a "Universal Constant" which has been given the name "C"

As emitted from its source, such as molecules, atoms, nuclei, moving electrons, etc., and measured *nearby*, this velocity appears to be quite uniform. But, has anyone measured the velocity of a photon arriving on Earth from, for example, a quasar after travelling through the quite far reaches of space? Just a question for the astronomers, really.

The shape of the photon.

What shape does the photon really have? Well, I think this is a good question, and one which I will keep asking for a while anyway. The wave people saw a plane wave spreading out in all directions transverse to the line of travel from the origin. Of course they couldn't account for the photoelectric effect this way. The particle people (sometimes the same people but on a different day of the week) saw a little blob of "energy" but could not account at the same time for the positive wave-like actions of the photon under other test conditions. De Broglie became famous for his predictions of the waves associated with particles having mass, such as the electron. He still did not solve the whole problem by a long shot. There remained the "model", or "shape" of a wave that is restricted in three dimensions and does not spread out much, but does a little as time, quite a good deal of it (like lots of light years), goes by.

I am so sure of this that I am writing an article about it. *This* article! I also think (although of this I am less sure), that I may know how to make a "giant photon."

Probably other people do also, which may well account for the pulsars. Maybe I'll get time to do it later, with help.

Requirements for a wave that does not spread out

Several requirements for a wave that does not spread out are listed below, starting from the consideration of the wave we already have, the vortex sound wave that is restricted in three dimensions.

1. It must be a single wave. A single event. Generated, radiated, and done with. You can send another one pretty close after it maybe in the next nanosecond but they must *not* be connected, and it is immaterial whether the second one is there or not. This makes it pretty nice for digital transmission of course! To be sure of this check up on the vortex wave you can make in a glass smoke ring box and radiate from it.

2. It must then, as a single wave be subjected to further treatment which will cause it to rotate on itself. Watch that smoke ring closely! It does this as it goes forward. In the electromagnetic model this rotation may be some form of repeated action (frequency?) which may be a type of action completely unknown as yet . . . Perhaps a rotation or alternation of its *internal fields,* possibly a spiral effect.

3. It must do this at the speed of light, which should be easy. It *is* light, and in a medium of which we know *naught*! We have drawn a blank there; Maxwell described some of its properties but no one has been able to "find" it so far. Maybe we amateurs

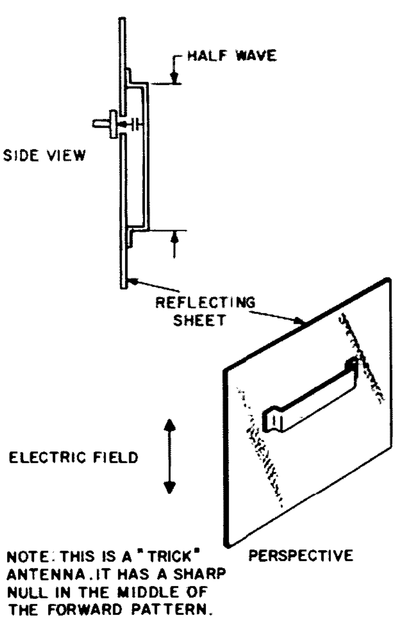


Fig. 6. Horizontal dipole which is vertically polarized.

can find it while the main crowd of physicists rush madly on with their thirty to forty "new particles" found in the supposedly tiny nucleus.

4. It must, when generated and travelling outward at the speed of light (which it is!), at the same time, be subject to polarization.

End of list of requirements, so far. There may well be more. Number 4 does not mean the type of polarization accomplished by optical workers, who pick out those photons polarized, for example, vertically, and then throw away those which are polarized horizontally.

This polarization describes the "electric field" as opposed to the "magnetic field". We are getting pretty close to real fundamentals now, so we have to watch words closely. After all, new theory many times requires new words, which goes "against the grain" (of thought) with some people, who credit themselves with a sufficient vocabulary to describe anything they can think about. Don't worry about this matter though. We are all groping in the dark here, I believe.

Polarization of the photon

This has always been a real tough subject. Not so bad in radio, where you can put a dipole sideways and be sure you are horizontally polarized. Even here you have to watch your step though. The dipole shown in Fig. 6, whose length is in the horizontal plane is nevertheless polarized vertically! Try it sometime!

But this photon now, how can it have a polarization? A little slug of energy moving out at the speed of light. How can it be polarized? Well, we know it does have such a property so we have to live with it. As far as I know, no one knows how to *emit* light which is polarized in one plane only, as is done in radio. This probably stems from, at least so far, an inability to "arrange" an atom so that it does emit polarized light. Quite a job I would guess! Still, some people are achieving remarkable minute maneuvers today like showing pictures of bacteriophages which are only a few atoms long.

Of course it would help a lot to know the shape of such things as atoms and photons. Maybe someday. Maybe the "giant photon" I'm proposing to build could help.

This question of polarization, to me, is the hardest part of the whole deal. At least I'm in there trying!

The medium

This "ghost," this "spectre," is always in the background, making physicists unsure of their work at times when dealing with light, remaining a bad question when leading electronic engineers are asked about it by juniors.

Personally I'm not afraid of it, but so far I haven't made much progress in dealing with it. I believe there is a "medium" but, in common with everybody else, I have no concrete ideas about it. I can only hope at present, that my ideas on the 3D wave as proposed in this article may suggest *something* (anything!) useful about it, and make it a little less an "out" subject and one which becomes a little more an "in" one.

There must be *something* there! So the photon is a "travelling, alternating, field". See you later on this, I hope.

Speculation on pulsars

Perhaps the pulsar is a "giant photon" type of radiation rather than a "plane wave" affair, and as such it could be using extreme directivity (does not spread out much) similar to the vortex wave.

In which case the calculated power of the pulsar needed to send such radiation to our earth may be in need of tremendous revision downwards. As mentioned, I think astronomers would appreciate help here. I sure need help from them!

In fact, in a recently received private communication from Arrecibo, P. R., I have been told that the pulse from a pulsar consists of one fell swoop of "frequencies" from A to Z with something that just might be a message built into it. Look at graph no. 1 again, please. The pulsars may soon really tell us *something!*

The particle-wave.

If the suppositions in this article finally lead to a clearing up of this century-old controversy, well fine. I'm 64 years old now, expect another ten years of useful work and would like to devote some of that time at least to the creation of a "giant photon" working model of the type of wave, with proper polarization to fit, which, from an aperture of about one wavelength, should hardly spread out at all for the first many millions of miles of travel. Beats radar doesn't it? The red shift gets to be about 3 db near the visible edge of our universe, so, if caused by light running down instead of Doppler, may turn out to be our oldest, biggest, and best "universal clock," and one which is known as such throughout said universe.

. . . K1CLL

Cable Pickup and Shielding

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Shielded types of cable, when properly used, at any frequency can provide a great deal of protection from interference sources. Their proper use and various types of special shielded cables are discussed in this article.

Most amateur installations use extensively various forms of shielded cables – for audio lines, low-level *rf* circuits, and for antenna transmission lines. Often such cables are used as a matter of convenience or because they are readily available, with their shielding ability being kept in mind, but as a secondary thought. This approach suffices for many installations because no real need exists for great care to be exercised as regards cable shielding.

However, there are instances when a station is located in an electrically noisy environment or internal problems of hum and feedback develop within a piece of equipment which require that cabling be properly shielded. Too many amateurs believe that the best they can do as regards cable shielding is to use some form of wiring with a woven wire covering or "shield." However, what really constitutes a "shield" depends upon a number of factors and what appears to be a physical shield may not, in fact, be a good electrical shield. To obtain an effective shield, one has both to understand what one desires shielding against and what the shielding capabilities of various cables are.

This article discusses some of the general considerations that are applicable to cable shielding effectiveness. The principles developed apply whether one is trying to shield against a hum problem inside a piece of equipment due to cable pickup or whether one lives in a noisy city environment and is concerned with bringing microvolt level signals from an antenna along a transmission line without having external noise sources mask or distort the signal. Books have been written on the subject of cable shielding and no brief article can cover all the techniques involved. However, the material presented should at least give some better insight into proper shielded cable usage and explain why the simple usage of shielded cable does not always instantly or immediately solve cable pickup problems.

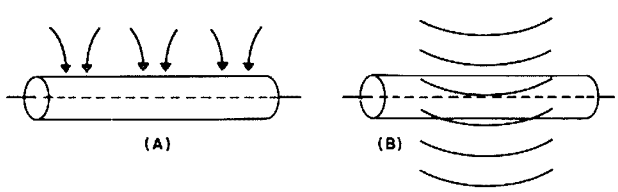

Fig. 1. Interference can couple to cable by capacity (electrical) or magnetic fields or a combination of the two.

Noise and Interference Fields

Probably the greatest problem in effectively shielding a cable is to really determine what the shield should be effective against. Coupling between a cable and some external source (noise field, radiated signal, a signal flowing in an adjacent wire, transformer field) can be either by means of capacitive (electrical) or magnetic fields. The field from a fairly distant radiated signal can produce the former type of coupling while a wire run close to a transformer will be coupled by the latter means. In a complex situation where a number of interfering sources must be shielded against, coupling can be achieved by a combination of both means.

Fig. 1 shows how both fields can effect a single-shielded coaxial type cable. The capacity coupled field is theoretically stopped by the outer conductive shield of the cable. Actually, this is not completely true, since most shields are only 80-90% effective. Still, such a degree of shielding suffices for many applications. The magnetic field passes through the woven copper-wire shield of the cable. Actually, nothing happens because the fields couple to the cable where somehow only a current can flow.

This takes place when the shield of the cable is grounded in some manner, as shown in Fig. 2.

Ground Connections

When a ground connection is placed at both ends of a coaxial cable (**Fig. 2A**)a loop (closed circuit) is formed consisting of the shield and the ground circuit. Thus, if the cable is subject to either of the fields shown in **Fig. 1**, they can cause a current to flow in the shield. Naturally, since the shield must also carry the desired signal current in one direction, the signal will be degraded by the amount of the coupled interference.

It is assumed, by the way, that the fields are coupled to the cable with such an orientation that they can induce currents. Normally, this will be the case since most interference has a random orientation. However, there may be special cases (inside a chassis, for instance) where the interfering field is fixed and one can achieve a considerable reduction in the couple interference by reorienting the signal cable.

Again, however, on the subject of shield grounding, one common idea is that the shielding effectiveness of coaxial cable' is enhanced by grounding as often as possible along the length of its run. Actually, it is possible that such ground can have just the opposite effect, as shown in **Fig. 2B**. The smaller closed loops formed can increase the induced current flow. Also, the ground path may have other currents from external noise sources flowing in it which will be coupled onto the shield of the coaxial cable.

Therefore, the best approach usually is to have as few ground connections as possible. In fact, the best situation, as shown in **Fig. 2C**, would be to have a single ground connection at the signal source. Thus, no

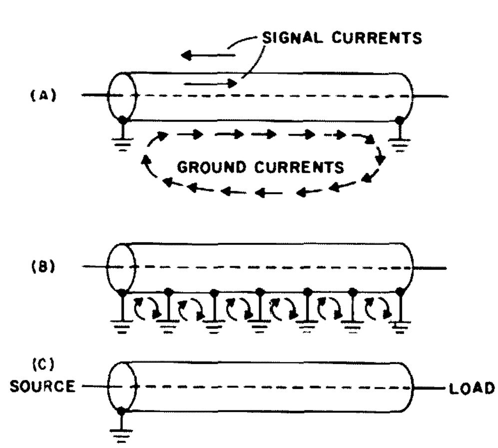

Fig. 2. Methods of grounding simple coaxial cable or shielded wire.

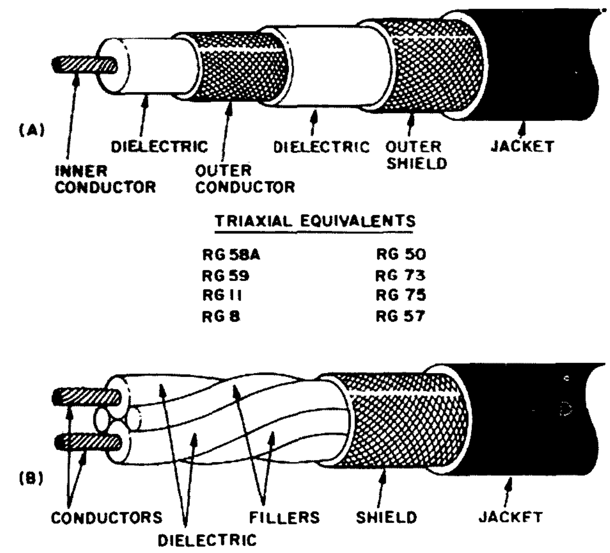

Fig. 3. Triaxial and Twinax cable construction.

closed loop would be present to allow induced current flow. In practice, such a method is not always possible, especially with low impedance cables, because of the impedance mismatch that occurs at the load end of the cable. However, the method can often be used with very good results with very high impedance cables. A variation on the method is to ground the shield of the cable at the load end through some sort of selective device – an *rf* choke, for instance – if a dc path through the cable is desired, but *rf* pickup induced currents are to be surpressed.

Special Shielded Cables

Single conductor shielded cable or coaxial cable is certainly not the only type of shielded cable available, although its common usage overshadows the availability of other types. It was mentioned before that the shield of a coaxial cable is not 100% effective. To retain flexibility while improving the shield effectiveness, double shielded coaxial cable is available (RG5A/V and other types). The cable has two woven shields directly placed on top of each other. At frequencies in the mf through vhf range, the shielding effectiveness is about 97%. The cable is used in the same manner as single-shield cable and all the considerations mentioned regarding grounding of the shields still apply.

If one takes a double shielded cable but insulates the two shields from each other, the result is Triax (**Fig. 3A**). This cable can be used as shown in **Fig. 4A**. The outer shield is connected to ground and the inner shield and conductor are used for the signal circuit. Because of the separate outer shield,

capacitive coupling does not affect the signal carrying circuit and the outer shield can be grounded as often as possible without harmful effects from ground currents. Of course, the value of the outer shield is lost if the equipment used is grounded to the same point as the outer shield. The cable can also be used to produce the effect discussed for Fig. 2C without causing any impedance problems by grounding the outer shield at *only* the signal input end. Thus, it can be a very effective means to reduce interference when a coaxial line is desired to an antenna in a noisy location. Triax cable is available in the usual 50/75 ohm impedances from a number of manufacturers. Some examples are Times TRF-502 and Amphenol 21-527. Such cable is not inexpensive but can be very effective. For short runs, tinned braid can be purchased separately and slipped over regular single shield coaxial cable to form inexpensive home-brew Triax.

Still another special cable is shown in Fig. 3B. Twinax, as this cable is called, has a twisted 2-conductor pair inside a single-shield. As shown in Fig. 4B, the shield is grounded to isolate the conductors from capacity coupled fields. The twisting design of the inner two conductors provides a great reduction from the effects of magnetic field induction since the currents induced cancel in alternate twisted sections. The cable is meant for use in a balanced transmission line system and is generally available in 90-150 ohm impedances (RG22/U, Belden 8227, etc.). A form of Twinax with a double insulated shield is even available, but only useful for specialized applications.

Checking Shield Effectiveness

The effectiveness of a shield is a complex thing to evaluate by test instruments because of the variety of fields over a wide frequency

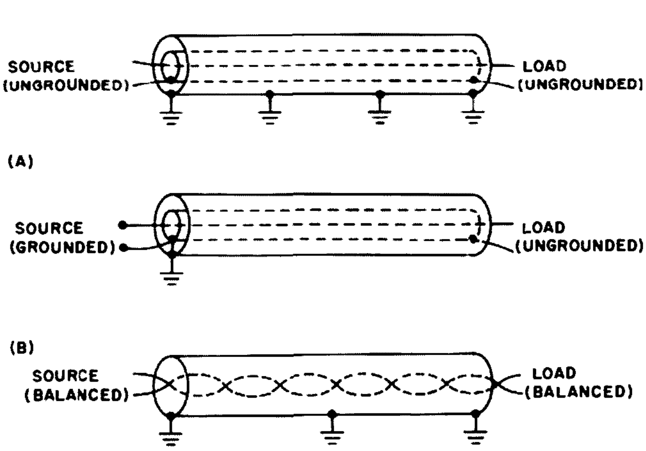

Fig. 4. Triaxial and Twinax cable shield connections.

range to which a cable might be subject in usage. However, checking shield effectiveness in an actual installation is not complex, and a simple method is usable no matter what type of cable is being used.

The method requires only a receiver tuned to the frequency at which the cable to be tested will be used and a *shielded* dummy load (a ½ watt resistor, for instance, placed *inside* a coax connector). The dummy load is placed on the receiver antenna terminal and a multimeter is attached across the receiver's audio output to measure output voltage (the headphone jack is usually the most convenient location using a 600 to 1,000-ohm resistor in place of the headphone load). The *rf* gain control is set at maximum and the *af* gain control used to set some convenient "noise" voltage level on the multimeter scale (usually 1-4 volts).

Without changing any receiver control settings, the dummy load is removed and placed at the far end of the cable run under test. The near end of the cable is connected to the receiver (or transceiver) antenna terminals.

The increased noise reading on the multimeter is now due to cable pickup. Even in the best of installations, there will be some increase in the meter reading because the dummy load and connector shielding are not perfect. However, in a good installation, the increase will be minor and certainly not more than 1.5 times the original meter reading.

This method can be used to check the pickup of a cable already installed or to check the improvement in an installation as different cables, grounding methods, etc. are tried. The important measure is only the *increase* in noise reading as the dummy load is moved from the receiver to the far end of the cable, not any absolute readings. The entire receiver "calibration" must be repeated for each frequency band of interest.

Summary

There is little sense or economy to spend money on sensitive antennas or equipment and then accept performance degradation because of cable pickup. Probably no cable can be made absolutely pickup-free in all interference environments. However, by following some of the general methods described, one at least can start to tackle the situation with something more than simple coaxial cable as the only possibility.

. . . W2EEY

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WWV — Pioneer in Standards Broadcasting

"National Bureau of Standards, WWV, Fort Collins, Colorado. Next tone begins at twenty-one hours Mountain Standard Time."

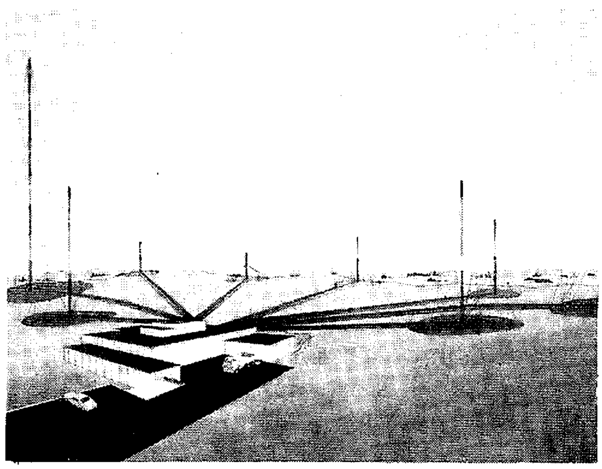
The National Bureau of Standards radio station, WWV, began operating from its new home in Fort Collins, Colorado, early in December 1966. The station was moved from Greenbelt, Maryland, to the present site, 60 miles north of Denver, at a cost to the government of $970,000. The move was prompted by rapidly obsolescing equipment, the need for a more central location, the high ground conductivity of the new site, and the proximity to the N.B.S. frequency standard at Boulder, Colorado.

WWV's services are among the most widely used and vital services provided by the National Bureau of Standards. Its time and frequency signals are used by ships, aircraft, electronic laboratories, radio and television stations, electrical power companies, and the makers of musical instruments (who depend on WWV's tone for standard pitch).

Amateur radio operators around the world account for 35% of WWV and WWVH (Maui, Hawaii) listeners. Hams use the signal to calibrate their equipment.

WWV joins two other N.B.S. standard frequency radio stations at the Fort Collins site. The stations, WWVB and WWVL, were established in 1963. They operate on low frequencies making possible world-wide coverage.

Station WWV broadcasts on frequencies 2.5, 5, 10, 15, 20, and 25 MHz. The broadcast are continuous, night and day, except for a four minute period each hour. The silent period commences at 45 minutes (plus 15 seconds) after each hour.



Artist's drawing of WWV and its antennas.

The 5, 10, and 15 MHz transmitters deliver 10 kw to the antennas, while the 2.5, 5, 20, and 25 MHz transmitters deliver 2.5 kw. The linear amplifier, which has a 40 kw input, is driven by a one watt driver. All of the antennas at WWV are vertical, half-wave dipoles, and are omnidirectional. They are fed with 50 ohm 3 5/8" coax cable. Antenna height varies from 20 to 120 feet.

At WWV, all modulation is double sideband amplitude* with 75% modulation on the steady tones and 100% on the second pulses and voice.

In case of a power failure the station is tied into two power grids in addition to having an emergency power generator.

Since December 1, 1957, the standard radio transmissions from WWV and WWVH have been held as nearly constant as possible with respect to the atomic frequency stand-

New antenna designs are tested out on 1/40th of the wavelength before the final installations are made. Here is a model of the 10 khz antenna to be built for WWVH. The model is on 400 mhz.

ards which constitute the United States Frequency Standard. The U.S.F.S. is maintained and operated by the Radio Standards Laboratory of the N.B.S. at Boulder, Colorado.

The frequencies transmitted by WWV are held stable to 5 parts in 10^{11} at all times, according to the National Bureau of Standards. Deviations at WWV are normally less than 1 part in 10^{11} from day to day. Changes in the propagation medium (Doppler effect, etc.) result, at times, in fluctuations in the carrier frequencies received, and may cause greater error than noted above.

Standard audio frequencies of 440 Hz and 660 Hz are broadcast on each carrier frequency at WWV and WWVH. The audio frequencies are transmitted alternately at five-minute intervals starting with 600 Hz on the hour.

The 440 Hz tone is the note A above middle C, which is the standard in the music industry throughout the world.

Universal Time (referenced to the zero meridian at Greenwich, England) is announced in International Morse Code each five minutes from WWV and WWVH. The time announcement refers to the time when the audio frequencies are resumed. The station also broadcasts a voice announcement every five minutes in Mountain Standard Time. It is given during the first half of the fifth minute and is in English.

In addition to the time signals, WWV also broadcasts radio propagation forecasts in International Morse Code during the last half of every fifth minute of each hour. The forecast tells users the condition of the ionosphere at the time of broadcast and for the following six hours. A world-wide network of geophysical and solar observatories feed information, which includes radio soundings of the upper atmosphere and short wave reception data, to the Telecommunications Space Disturbance Center at Fort Belvoir, Virginia. The forecasts are sent at 0500, 1200, 1700, and 2300 UT. They are broadcast in Morse Code as a letter and number. The letter identifies the radio quality at the time the forecast is made. The letters denoting quality are "N," "U," and "W." They signify that the radio propagation conditions are either normal, unsettled, or disturbed. The number portion is the forecast of radio propagation quality on a typical North Atlantic path during the six hours following the forecast.

The forecasts are made for the North Atlantic area using a path from Washington, D.C. to Frankfort, Germany as a standard. They are used, for the most part, for direct point-to-point radio telephone transmissions. The scale used for radio quality is based on a one to nine scale which follows:

Disturbed grades (W):
1. Useless
2. Very poor
3. Poor
4. Poor-to-fair

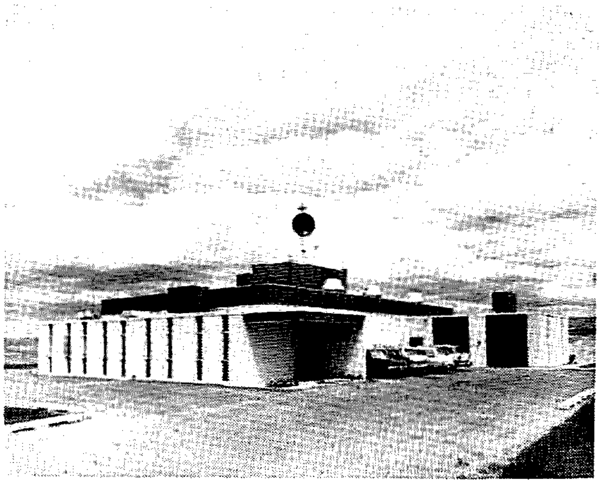
Unsettled grade (U):
5. Fair

Normal grades (N):
6. Fair-to-good
7. Good
8. Very good
9. Excellent

Another service of WWV and WWVH is the broadcast of current geophysical alerts. The alert tells what days there will be outstanding solar or geophysical events and when these events have occured in the past 24 hours. The broadcast is made during the first half of the 19th minute of each hour. The letters GEO are sent in CW followed by a letter repeated five times. The letters are:

M–Magnetic storm
N–Magnetic quiet
C–Cosmic ray event
E–No geoalert
S–Solar activity
Q–Solar quiet
W–Stratospheric warning

A time code is also broadcast by WWV for one minute out of each five, ten times an hour. The code provides a standard base for scientific observations. The code is transmitted at a 100 pps rate and is carried on a 1,000 Hz modulated signal. The code con-



WWV transmitter building.

tains the Universal Time in seconds, minutes, hours, and day of the year. The code is synchronized with the frequency and time signals.

The time standard uses a Cesium Atomic Beam to calibrate the oscillators, dividers, and clocks, which generate the controlled frequency and N.B.S. time scales. Information from this reference is fed to receivers which monitor the transmissions from Fort Collins. The signal is compared to the reference phase. If an error exists, a signal is transmitted from Boulder to Fort Collins by a 50 MHz transmitter. Automatic correction equipment at Fort Collins corrects any error.

The oscillator controlling the transmitted frequencies and time signals is continuously compared with the LF and VLF signals. Adjustments are then made to the controlling oscillators. To assure that systematic errors do not enter into the system, the N.B.S. time scale is compared with the transmitting station clocks by the use of a very precise portable clock. By this method time synchronization to a few millionths of a second can be attained.

...WA1AAU

*(Ed. note. *SSB operation is planned for the near future.*)*

Big Do in Bombay in December

The First All India Amateur Radio Convention will be held in Bombay on December 27-30 this year. If you have a chance, by all means plan to visit. Write to VU2TP for further particulars.

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Basic Theory and Application of Transistors

A transistor, like a triode vacuum tube, is basically an amplifier of electric voltages and currents. However, unlike the electron tube, it is in a solid state, therefore the electrons are passing through a solid material rather than through a gaseous medium.

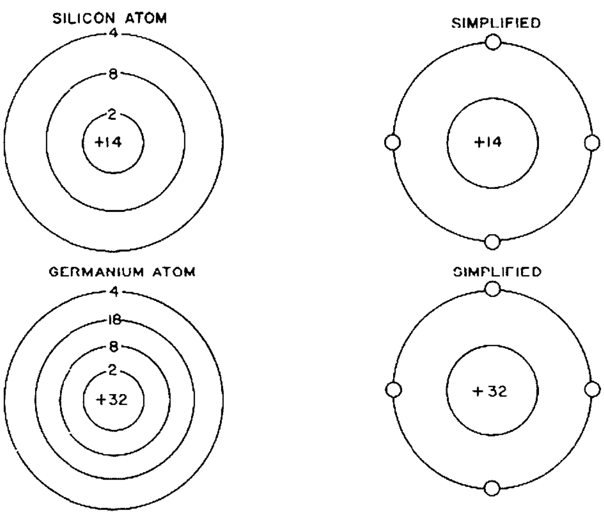
The transistor was invented forty-two years after the electron tube by W. Shockly, W. H. Brattain, and J. Bardeen of Bell Telephone Laboratories. These men demonstrated that a solid state device could replace the vacuum tube in performing all of its functions more efficiently.

There are four main advantages of transistors over vacuum tubes. These are size, shock resistance, operating temperatures, and slowness of their aging. Because a large gaseous space is not needed in a transistor, their physical size is many times smaller. A transistor does not require filament power for its operation; no heat is generated internally (this is the major cause of failure in a tube) under normal operating conditions. Also because of this fact, transistors have an almost indefinite life because there is no filament to burn out. Transistors, for the most part, are shock resistant with the exception of fracturing of the internal structure from a severe shock on one of its leads. Transistors are built inside of a small metal case rather than in a glass envelope as is the electron tube; therefore, they are not susceptable to breakage.

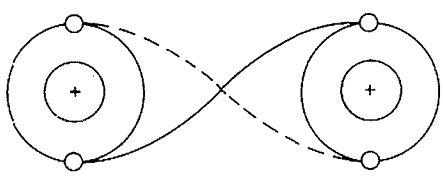
If a particle of a substance is cut in half, what do you have? Two halves, both identically the same if care is taken. What would happen if it was cut in half again and again until it could no longer be seen? Does it disappear? No, it is only divided up into the smallest particles of the substance (which retains all of its chemical properties) called atoms. An atom consists of three main subparticles. These are the proton, the electron, and the neutron. These three particles are situated in two main areas of the atom. The protons (positively charged) and the neutrons (neutrally charged) are in the heavy center of the atom, the nucleus. The electrons orbit around the nucleus in eliptical orbits. Each atom contains an equal number of protons and electrons; thus, the sum charge is 0. They are electrically stable but chemically unstable.

The electrons are in different orbits or levels around the nucleus according to the amount of energy that they have. These orbits are labeled; K, L, M, N, etc. The K orbit can hold two electrons, L-8, M-18, N-32. In the study of the flow of electricity we are concerned only with the outermost or valence electrons. The charge of the atom is determined by whether the atom wants to give off or take on electrons to reach a chemically stable state. For example, if the K shell had two electrons in it, it would be stable both chemically and electrically

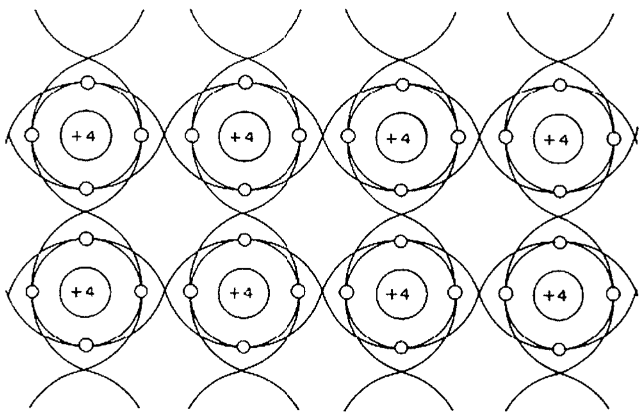
because the plus and minus charges would balance out, and since the shell is full, it neither wants to give off or take on electrons. If the atom contained three electrons, two would go into the K shell and since this is full, the third would go into the L shell. The atom wants to have a full outermost shell, so it can either take on seven more or give off the extra electron. This process gives the atom a charge of plus 1 from the addition of the two charges: +2 -1. It gives off the one instead of taking on seven because there is less energy required. Atoms which have a positive valence are classified as metals. Those which have a minus charge (atoms in which it is easier to take on electrons) are called non-metals. Those which can give or accept electrons with equal energy are called transition elements (Ex. element with 4 electrons in L shell). Metals are called conductors, non-metals, non-conductors, and transition elements, semi-conductors. A semi-conductor is neither a metal nor a non-metal but is in between the two in its properties. The most common semiconductors are silicon (At. No. 14) and germanium (At. No. 32).



As shown in the diagram, both silicon and germanium have similar outermost shells, therefore they have almost identical properties. Silicon and germanium are in a crystal lattice which accounts for most of their conducting properties.

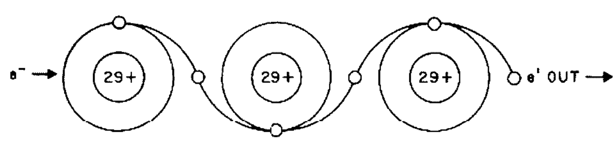


Breaking the crystal down into only two atoms, it is shown in the diagram how an electron is shared in a covelant bond. Since all electrons are almost exactly alike, an electron of one atom can take the place of an electron in another atom. In this diagram the atoms are spaced so close together, that the electrons of one atom go into the orbit of the other atom. If the atoms of the crystal lattice were drawn out excluding inperfections it would be diagramed as below:



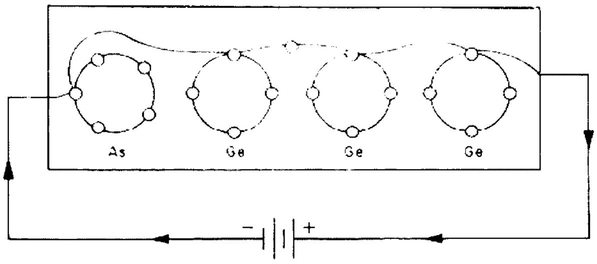
In the diagram all of the electrons go into the orbits of the other atom; however, there are never more than four electrons around an atom at one time.

This diagram may also show how electricity is conducted. Copper, which can be basically diagramed in the same manner only with one electron in the outside shell, is one of the most common conductors in wires. If an electron is pushed into the end of a wire, the electron forces another one out the other end. In this way, a steady voltage produces a steady flow of electrons out of the end of the wire.



Since silicon and germanium are only semi-conductors, a slight impurity must be added for them to be able to conduct enough for the purposes of a transistor. If the resistance of a pure block one centimeter long is measured, its resistance would be in the order of hundreds of thousands of ohms. If a small piece of arsenic or antimony is added and the mixture recrystalized, the resistance would be less than one hundred ohms.

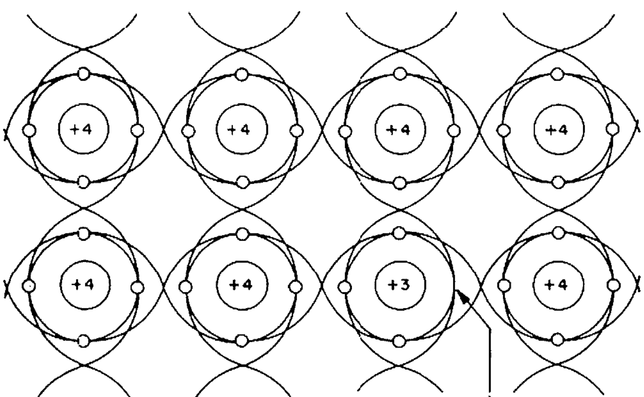
In the diagram below, the arsenic atom contains five electrons. This means there is one extra electron (the fifth) which will not combine covalently.



The diagram shows what would happen if a current were passed through it. The electron from the power source pushes off the extra electron from the arsenic and takes its place. This in turn pushes off an electron from germanium to germanium, and continues until an electron is pushed from the last germanium atom in the bar and the flow of electrons is completed.

Semi-conductors, which contain this extra electron in some of its atoms, are called N-type material; they are slightly negative. The electrons, because they exist for the most part in excess, are called majority carriers; the holes which exist from the loss of an electron are called minority carriers.

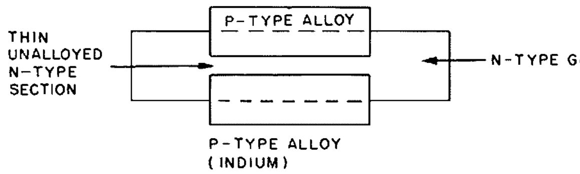
P— TYPE MATERIAL



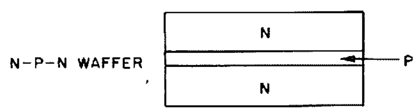
If instead of arsenic or actinium being added to the semiconductor material, gallium or indium (+3) is added, there will be a need for electrons in some of the atoms. The same process will occur as in the N material conductor, only in this way the current will flow in the opposite way. In this case the holes are the majority carriers and the electrons, the minority carriers. This material is called P-type material. The impurities which are added to the semiconductor are called "dope" and the process is called "doping."

There are two main types of transistors. These are P-N-P and N-P-N. These are named by the material out of which they are made and the order in which they are connected. The connection point is called a junction.

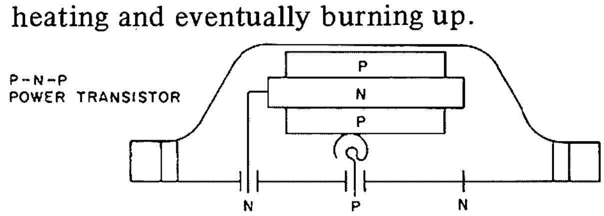
There are three ways of forming a junction. These are the diffused-alloy process, the rate growth process, and the gaseous diffusion method. In the diffused-alloy process, tiny dots of indium are pressed into each side of a slice of germanium. This is placed in a temperature controlled furnace where the indium melts and gradually diffuses below the surface of the N-type germanium. A P-type alloy is thus formed in the surface of the indium. An extremely small unaffected N-type germanium separates the alloys. This process is used to produce P-N-P transistors.



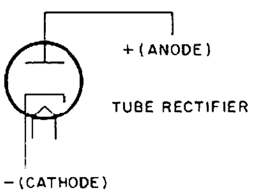
"In the rate growth process, molten germanium is doped with impurities so proportioned that, although the original molten mass is in P-type germanium, it changes to N-type germanium when the temperature of the mass is carefully controlled. This change is dependent upon the rate at which the forming ingot is withdrawn from the moulten bath as the crystals slowly grow on the ingot." In this way a wafer crystal is grown with two N materials on either side of a very thin P-type material. This forms a N-P-N junction.

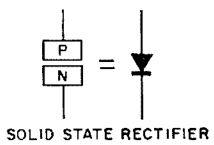


The gaseous diffusion method of junction is mainly used in the manufacturing of large power transistors. In this process the base material, N-type germanium or silicon, is heated with a P-type impurity to a very high temperature at which point the impurity forms sufficient vapor to begin to diffuse slowly into the surface of the base material, forming a P-N-junction on each side. The N-type base material is slowly converted into P-type material as the process continues. These large junctions are necessary in power transistors where heat must be dissipated quickly to prevent the transistor from overheating and eventually burning up.

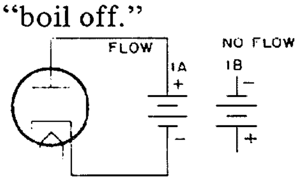


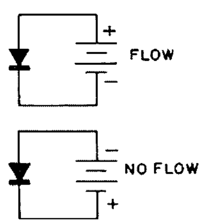
If a P-N junction is made, the P material is positive or the anode, and the N material is the negative or cathode. In this way a diode can be formed out of solid state material rather than a vacuum tube.





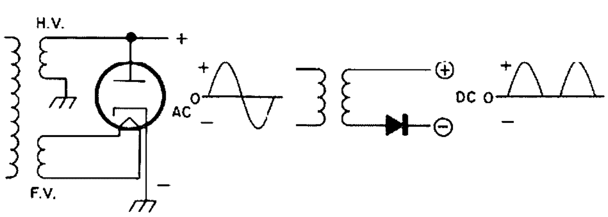
If a battery is connected across a diode, the current (which flows from - to +) will only flow in one direction. In **Fig. 1A** the negative of the battery is connected to the cathode and the positive to the anode or plate (see appendix). Electrons are given off from the filament and collected by the plate. However, when the battery is reversed, **(Fig. 1B)**, the + to the cathode and the - to the anode, no current flows for the cathode does not have a surplus of electrons which it can "boil off."





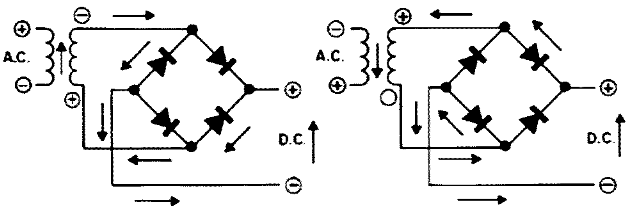
This same theory applies to the semiconductor diode. When the batteries' - pole is connected to the N part of the diode and the + pole to the P side, current flows. When the battery is reversed, no current flows because of the lack of electrons carriers in the P region. When the battery is connected forward again, both holes and electrons cross the junction, join with each other and cancel charges. This allows the electrons to enter the N side and leave the P side.

A single semiconductor diode may be used as a rectifier. (change alternating current to direct current).



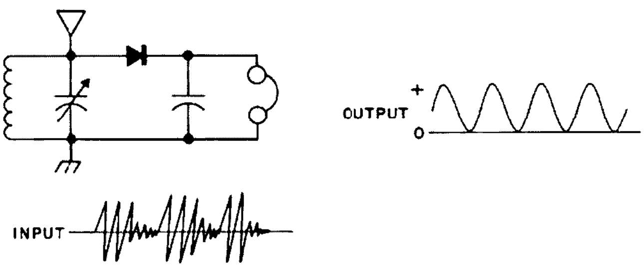
In the first circuit, a vacuum tube is used. Because of this, a filament voltage supply is needed which uses a great amount of current and also generates a great amount of heat. In the semiconductor circuit, no filament power is needed, thus no large power supply and no heat is generated. Also, semiconductor diodes are about 99% efficient. In a single

diode circuit, the negative peaks (of the sine wave) are cut off during one half of the cycle because the diode is only conducting for half of the time. This stoppage of current flow may be prevented by using four diodes in a square circuit called a bridge circuit. In this circuit, current flows continuously therefore eliminating the nulls.



This current is much easier to filter (smooth out peaks) and gives a much stabiler dc voltage.

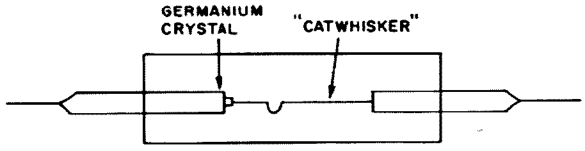
A semiconductor diode may also be used as a detector in a crystal diode radio. In the diagram, the high frequency ac wave from the transmitting station is picked up by the antenna and the exact frequency is tuned by the L. C. (coil-capacitor) network. This signal is rectified into dc current which powers the headphones.



There are two main types of rectifiers in use today. These are germanium and silicon. These two are very similar in outside structure, however, their electrical characteristics vary greatly. A germanium rectifier can handle up to about 250 ma of current at 85° C. Above these specifications the crystal lattice burns out. For higher power and temperature, a silicon rectifier is used. This is similar in construction to the germanium rectifier except that a crystal of silicon alloyed with aluminum is used to form the P-N junction.

This rectifier can handle over 750 ma at room temperature.

Both types of rectifiers have what is called the reverse current. This rating is given for all rectifiers in their specification sheets and tells the amount of current which the rectifier allows to flow back during the + half of the cycle. A typical reverse current rating, as in a 1N91 diode, is two 125 ua which is relatively small when compared to the forward current rating, which is about 150 ma. A third type of diode, which is used for low power applications, is the point contact diode. Point contact diodes are usually made out of glass and thus are much more fragile. In this diode a small piece of germanium is used as the N-type material with a dot of P-type diffused into it.

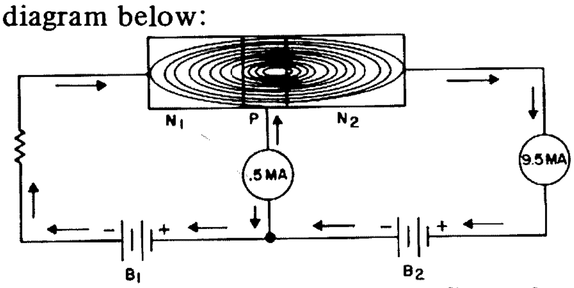


POINT CONTACT DIODE

One side of the germanium is placed against one of the conductors, while the other side is attached by a fine phosphor-bronze or beryllium-copper wire nicknamed "cat whisker."

If two P-N junctions are placed back to back having a common thin N junction, a P-N-P junction is formed. This type of junction (also reversed called a N-P-N junction) is called a transistor.

There are two possible ways to bias (supply voltage) a transistor: positive and negative bias. These are shown in the diagram below:



In the case of B_1, the current flows from the negative pole of the battery through the current limiting resistor (if it were left out almost infinite current would flow burning out the transistor) from the end part to the P- material and through the meter which shows a small flow of current. This type biasing is called forward bias. As shown in the case of B_2, a great amount of current flows as in the meter reading; this section is reversed bias.

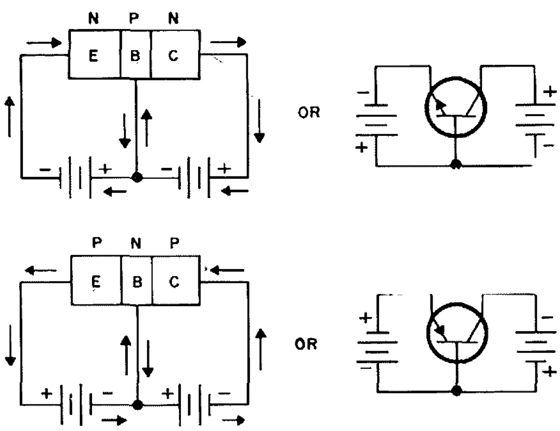
In an N-P-N transistor as in the diagram N_1 is labeled the emitter (for it emits the electrons), P the base (because it formed the base support of early transistors), and N_2 named the collector, C, for it gathers the electrons which flow from the P section. These parts are equivalent to the cathode, grid, and plate respectively a vacuum tube. The batteries may be labeled emitter battery or Ee for B_1 and collector battery or E_c for B_2. A P-N-P transistor is labeled in the same way except that the transistor polarities are reversed.

As mentioned previously, the emitter current is very slight with only E_e supplied. This is because of the shortage of the majority carries and the base. However, if both E_e and E_c are connected, the emitter supplies electrons which are forced through the base and pulled through the collector to the positive battery terminal. Only about 5% of the total current flows out through the base while 95% flows through the collector.

"Through this we conclude that the emitter battery controls the potential between emitter and base, that this potential controls the current that flows from emitter to collector but that the base itself takes very little of this current."

A P-N-P transistor acts in a similar way except that the majority carriers are holes rather than electors. Because of this the battery polarity must be reversed or the transistor will be destroyed.

The ratio between the elector current and the emitter current is called Alpha ($\alpha = \Delta I_c / \Delta I_e$) because of resistor differences between the emitter-base and the base-collector parts of the transistor, different voltages must be used in the two parts; Example of a typical transistor would be E-B of 250 Ω and B-C of 300,000 Ω. E_e would only have to be around 1.5 volts.



E_c would only have to be up to 45 volts to get a good output power.

Resistance gain in a transistor is a ratio of output resistance, R_L, to the input resistance, R_i, provided that alpha is 1.0 (alpha is usually .95 to .99). If the two formuli are combined with the formula for voltage gain in an amplifier $VG = \Delta E_T / \Delta E_i$, we get the formula for the voltage gain as $VG = \alpha R_L / R_i$ Example of a voltage gain would be 100 R_i and 100,000 R_L with alpha equal to .95. The voltage gain would be (.95) x (100,000/100) or 950. Substituting in the formula for power gain as in Ohms Law into the previous equation we get: $PG = \Delta I_c^2 x R_L / \Delta I_e^2 x R_i$. Since $\Delta I_c / \Delta I_e$ is α, we get simply

$PG = a^2 x R_L / R_i$. If the original set of values are used, we would get: $PG = (.95)^2 x 100{,}000 / 100 = 903$. This number should show that, contrary to belief, relatively large power gains are possible in transistors.

There are many factors which must not be exceeded in the transistor. Some of these are current, voltage, temperature and heat dissipation. The current to all transistors must be limited, thus a limiting resistor is used in series with a power supply. If this current rating, which is always given in a specification sheet, is exceeded, the transistor will heat up and burn out. This factor is generally the same for voltage. This rating is also given in a specification sheet.

Most germanium rectifiers and transistors break down or burn out when the temperature approaches 100°C so silicon is used for many transistors in its place. In this way a transistor can operate under much more severe conditions. The transistor also creates a small amount of heat under normal conditions. If these conditions are exceeded, the transistor may build up enough heat so that it will burn out. However these conditions may be exceeded by using heat sinks. These are ribbed metal devices which help to quickly dissipate the heat away from the transistor so that more power can be applied. The power may be increased 4 to 5 times its normal power.

There are many signal characteristics of a transistor; some of these are alpha- cut off frequency, input impedence (Z_i), out put impedence (Z_O), noise figure (NF) and previously mentioned, power gain.

Alpha cut off frequency is the frequency at which the current gain drops off at a value of .707 times the original gain. This means that if the original current was 1 ma, the current at the cut off frequency would be .707. The transistor does not stop functioning at this frequency, but only loses a large percentage of its efficiency.

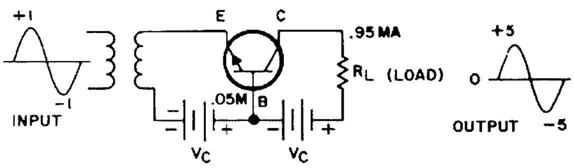
The input impedence is the measurement of resistance between the emitter and the base. This impedence is relatively low (around 250 ohms). Output impedence is the resistance measured between the base and the collector and is relatively high (around 5 meg. ohms) Both the input and output impedences must be matched to the circuit component's impedences. This is done by the use of input and output impedence transformers.

A certain amount of noise is generated in the transistor. This is serious for the noise is amplified along with the signal. The noise is measured in decebel (db), and in transistors, and is about 10 db. This figure increases inversely with the frequency, that is, the noise increases while the frequency decreases. Power gain may be restated as taking the log. of the power gain in db from the ratio of power gain:

$$\log (a^2 \frac{R_i}{R_L}) = \frac{db}{10}$$

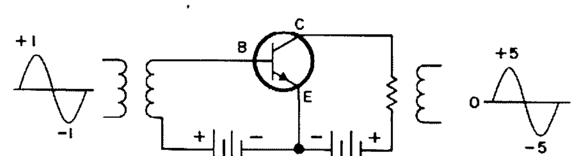
The most common use of transistors today are in amplifiers and oscillators. There are three basic types of transistor amplifiers, but, because of its simplicity, only the common base circuit will be fully explained.

In the common base amplifier, the base is connected with both the emitter and collector battery. As shown in the diagram, a signal is completed through the input of the emitter of the transistor. About 5% of this amount returns through the base because of the resistance previously mentioned. The rest of the power would go out through the collector circuit.

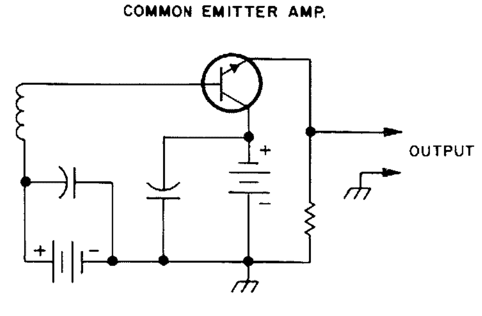


COMMON BASE AMP.

Since much more voltage may be placed on the collector of the transistor than on the emitter, more voltage and thus more amplitude is added to the input signal.



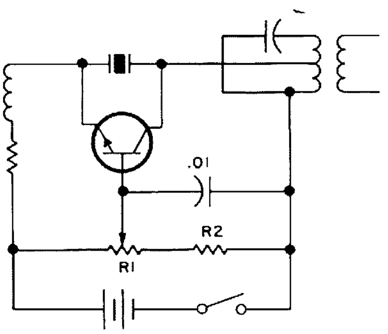
COMMON EMITTER AMP.



COMMON COLLECTOR

If the output of the amplifier is recoupled to the input, it is called an oscillator. This oscillator has a specific frequency which is

determined by a LC network. Taking the simple practical oscillator below:



This circuit will oscillate at higher frequencies, depending upon the transistor that is used. The crystal (a quartz crystal in a case) which is connected across the collector and the emitter, keeps the oscillator resonating at a specific frequency. The crystal acts like a high Q (quality factor) series as a resonant circuit. The coil is a tuned tank circuit which also determines the resonant frequency; however, not as exactly as does the crystal.

When Edison first discovered the Edison affect in the light bulb, people were amazed. When the electron tube was invented, people thought it was a miracle that voices could be transmitted and received through the air. Some went further on this idea and invented the transistor. Up to a few years ago, the miniature transistor was thought to be the ultimate in perfection of quality and size. However, more research was done and integrated circuits have been invented. These are small blocks about the size of transistor which may contain as many as 14 transistors, and their associated parts such as, resistors, capacitor, etc. This miniaturization was made possible by the discovery of film resistors and capacitors visible only under a microscope and which have transistors that function even better than those circuits built on a conventional circuit board.

Through the use of transistors, it is now possible to shrink the size of electronic equipment many times so that it is both lighter and smaller in size. This is of great importance for its use in space capsules where space and weight are very valuable. These electronic marvels also affect the homeowner, for now small transistor and integrated circuit radios are being made. Also possible through the use of integrated circuits and transistors are miniature television sets and television cameras which may easily be carried around with the power running off a battery pack. In this way transistors have shown their immediate success to both the scientist and the common man alike.

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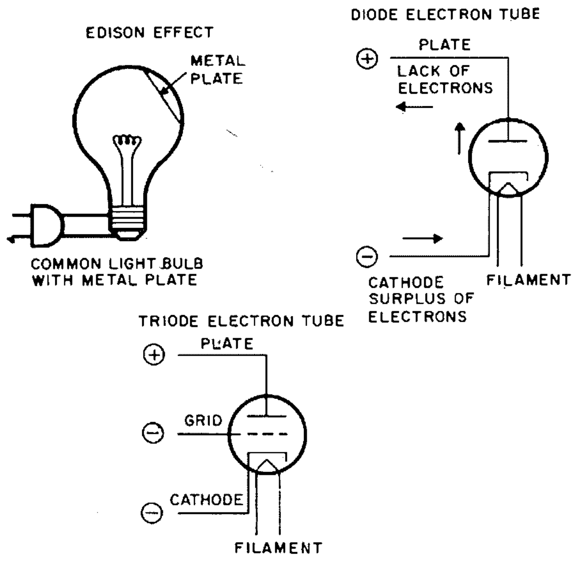
APPENDIX

Basic Theory of Current Flow in an Electron Tube

A filament in a common light bulb is made out of a type of metal which when an electric current is passed through it, heats up and glows. This happens because there are more electrons put into the wire than it can carry easily; thus, the wire heats up from the energy that it can not carry. If a metal plate were placed inside of the bulb, a cloud of electrons would surround it because it would have fewer electrons than the filament, thus being relatively positive. This effect is called the Edison effect, named after its discoverer, Thomas Edison. The electron tube was invented upon the principle that the cathode "boils" off electrons and the plate gathers them and returns them to the power source. Since the cathode has a very great negative charge and the plate has a positive charge, the tube can conduct only in one direction, negative to positive.



DIODE WITH GRID = TRIODE

If a screen-like element is placed between the cathode and the plate with a slightly negative charge, it will be slightly positive compared to the cathode and negative compared to the plate (not as negative as the cathode). In this way the grid, as it is called, is used to control the flow of current. By varying the grid current slightly, the plate voltage and current vary greatly. Just as in the transistor, the relatively small voltage and current from the cathode (or the emitter in the transistor) is "amplified" to a higher power level.

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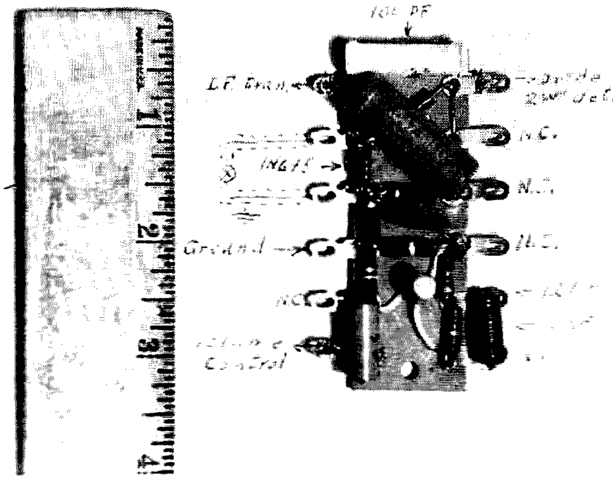
Series Gate, Solid State

When I recently decided to go fully transistorized, receiver-wise, on two meters, I decided to use a transistorized converter working into a transistorized broadcast receiver. The only problem that arose was that of the noise clipper. Having had very good results in the past with tube-type diodes in a series gate configuration, I decided to follow the same circuitry.

As in all series gate clippers, it is necessary to have sufficient voltage developed at the second detector for proper operation; however, with transistorized circuits and solid state diodes, instead of the preferred five volts, the voltage developed across the second detector is in the microvolt range. In order to raise the ac voltage, the second detector diode was moved from the low impedance tap to the outside connection of the output *if* transformer. This in itself is not sufficient for proper clipper action, so the clipper diode was put in a state of conduction. Voltage was derived from an existing resistor network in the receiver, and a 1 meg. resistor from the cathode side of the clipper diode to ground, completed the dc path.

The clipper diode selected was one that has a high back resistance (IN 645). As this is a broadcast receiver, and will at times be used as such, it is necessary to short out the diode to prevent distortion of music. In so doing, be sure to use individually shielded wires so there is as little capacitance across



Series gate limiter.

the diode as possible. Keep these shielded wires as short as possible.

Bench test, using a diode noise generator to the converter and an oscilloscope across the volume control. It was noted the clipping action started at approximately 60%, with the circuit components shown. This, of course, is on the positive half of the cycle, as this is a half-wave clipper. No clipping action takes place on the negative side. However, as the signal cannot go below zero, the extra components necessary for full wave clipping are not worth using for the results achieved.

Field tests of the clipper were conducted as follows: With an automobile having no suppression, and using a 5/8 wave whip

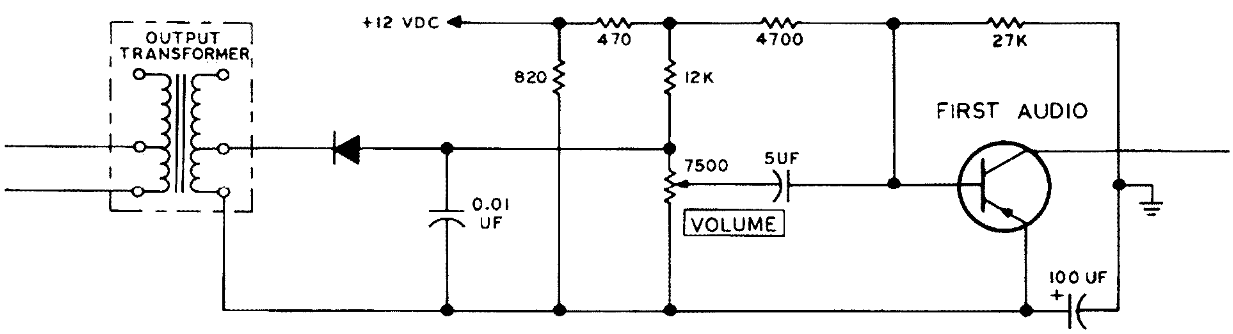


Fig. 1. Original 2nd detector and 1st audio.

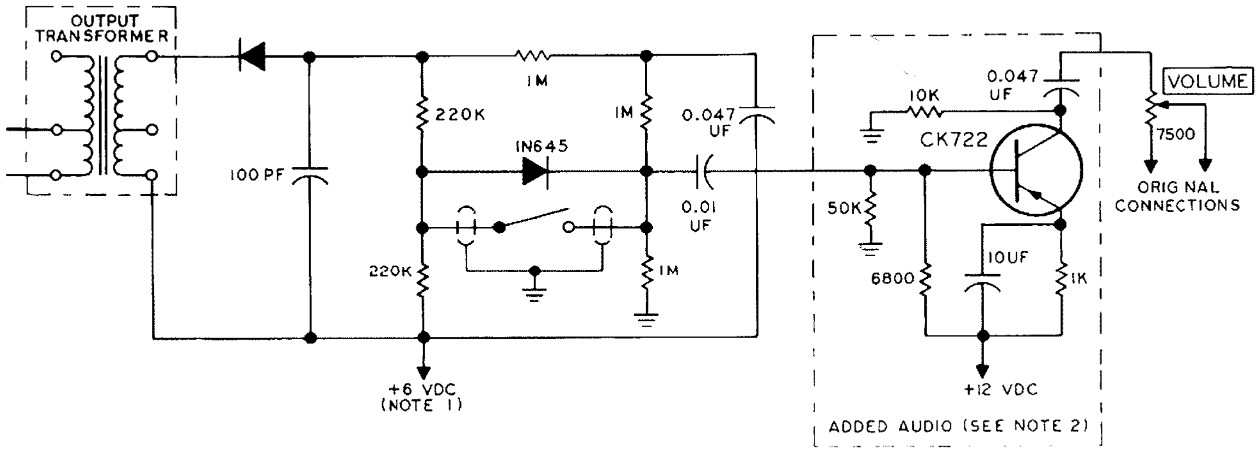


Fig. 2. Modified 2nd detector, clipper and audio. If the added audio is not required the .01 may be connected directly to the volume control.

mounted on the roof, I drove to an isolated spot and listened to various signals on the air. Picking one that had a signal strength of S4, I started the engine. The radiated *rf* noise tore up the signal beyond the point of intelligibility. Snapping the clipper on restored the signal to readability. Now moving to a highly congested area and parking near an intersection and tuning across the two-meter band, the same signals heard in the isolated area were heard here. However, with the clipper off, copy was impossible.

The clipper shown here is as good as any I have ever used, either homebrew or commercial. As in any series gate clipper, some audio is lost; however, for my own use, it was still more than sufficient. For those who play their radios loud, however, an extra state of audio has been added. Be careful, though. You may lose your speaker cone!

For those who will use this circuit, first study the second detector circuit of your broadcast receiver. There will be variations among manufacturers; however, in most cases the circuit will be adaptable.

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Improving NC-300 SSB Reception

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Now that NC-300's are on the used market at attractive prices there are many people interested in modifying them. The NC-300 was designed in 1954, and is rather inconvenient for SSB operation, but not very much work is required to improve it considerably. The agc system gets the most effort, since stronger control and a more appropriate attack/decay performance are required.

The first thing you need is a good schematic. I'll suppose you have that, and let's go to **Fig. 1**. A five volt signal at the second detector gives about six volts at pin 2, and this feeds the S meter and the agc bus.

In the original circuit the charge time constant was something like 25 milliseconds and the discharge time constant only slightly longer. These values seem good for AM, especially on a fluttering VHF signal.

But for sideband, the cathode follower becomes operative, thanks to a spare clip on the mode switch, and drives a voltage-doubling rectifier which provides about 12 volts of agc for the same drive at the second detector. This is applied through a diode to a point on the agc string where the discharge resistance is over a megohm, in order that a long time constant can be obtained more easily.

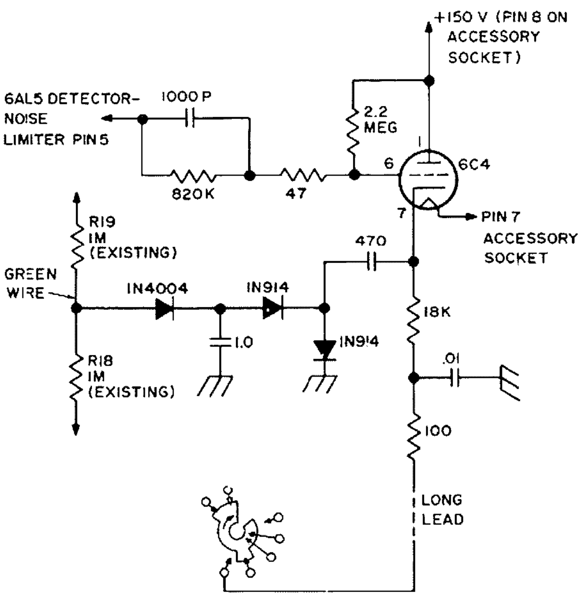

Fig. 1. Schematic diagram for modifying the NC-300 for improved SSB reception.

The actual charge time depends on the value of the 470 pF capacitor and the cathode resistor, but the 1 mF capacitor can be charged in less than 30 milliseconds without loading that last tuned circuit any more than it is already. The one-second discharge time constant seems about right, in listening tests.

The net effect is to hold down the level in the *if* amplifier, but there still seems to be adequate audio in the "SSB" position of the mode switch.

The cathode follower socket can be mounted in one of the ventilation holes next to the 6AL5, or the whole thing can be hung in midair, so to speak, in the considerable space beneath the chassis and under the accessory socket. The tube type is not critical, but do try to use the resistor values specified.

The mode switch has an unused, accessible clip next to that grounding out the agc bus in the CW position. This serves to turn on the cathode follower in the sideband position only. The wire runs along the cable which threads through the dial mechanism over to the vicinity of the audio gain control, then back to the second detector region.

A two-lug strip is attached to a bolt handy on the coil compartment, and carries the hundred ohm resistor and the bypass. Keep that grid lead short. The whole thing looks sort of temporary the way I did it, but seems to work okay.

Other Suggestions

The selectable-sideband feature used in some Hallicrafter receivers is easily added. See the second half of W6HOG's article in the April 1966 issue of 73, page 95. Ignore the first part of this, and item 2 is in error.

A 2135 kHz oscillator will have a harmonic in the 15 meter band. It is desirable to crystal-control the second oscillator on 2295 kHz because the second oscillator is responsible for most of the receiver's drift, especially drift due to varying humidity.

. . . W1OOP

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AFSK Generator

Here is a versatile crystal-controlled AFSK generator using digital ICs. In addition to providing an accurate source of mark and space tones (accurate to less than 1 hz with tone amplitudes within 1 db of each other) it also contains a microphone preamp. The generator displays no keying transients, and three methods of keying are provided.

Evolution

I had long contemplated using a stable 425 hz source and then selecting the 5th and 7th harmonics to produce the mark and space tones of 2125 and 2975 hz in an AFSK generator. However, no practical means of executing this idea was apparent until Motorola RTL digital ICs came on the market at a reasonable price. Although the IC can not be used to multiply, they can divide. So, we design backwards:

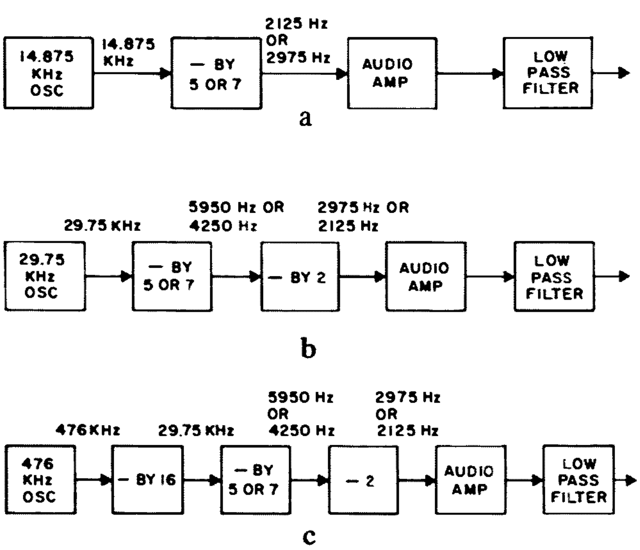


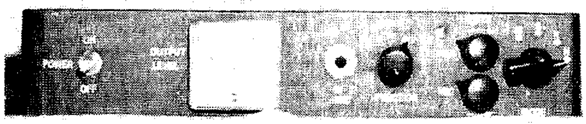
Fig. 1. Three stage evolution block diagrams.


Overall angle shot of unit. The unit is housed in a cast-aluminum box which was covered with wood-grained contact paper.

If two frequencies are each harmonics of another frequency, it follows that they are also sub-harmonics of still another frequency. In this case 2975 and 2125 hz are the 5th and 7th sub-harmonics of 14,875 hz. Now, we have arrived at a single signal source to provide both mark and space signals.

Since this device was to be used on 2 meters FM, sufficient audio was required to drive the primary of the usual carbon microphone transformer. An RCA CA3020 IC audio amplifier is adequate for this purpose. And it doubles nicely as a microphone preamp as well. However, there was the problem of transforming the IC divider's square wave output into sine wave tones. This was accomplished with a low pass filter following the audio amplifier, suppressing the square wave's higher harmonics, and producing sine waves.

This was the original idea as shown in Fig. 1a. But the new approach presented the



Head-on front shot. The narrow front panel made control location a bit of a problem.

problem of passing 2975 hz through the low pass filter with less than 1 db attenuation, and, at the same time, suppressing 4250 hz (the second harmonic of 2125 hz) to at least 40 db down. However, this turned out not to be a problem since, according to Fourier, there are no even harmonics generated by a symmetrical square wave – just odd ones. So, if the input frequency of 14,875 hz is doubled to 29.75 khz, we can then add a divide-by-two stage after the divide-by-five or -seven stage. Now, the lowest frequency to be concerned about is the third harmonic of 2125 hz, or 6375 hz. It is taken care of by the simple 5th order Chebyshev filter. **(Fig. 1b)**

Now, about that basic 29.75 khz signal source – how do we obtain it? One solution would be to use two cross-coupled NOR gates in an astable multivibrator. But these could be trouble-makers, since the oscillation frequency can be affected by supply voltage and temperature variations. Another possibility considered was a uni-junction transistor relaxation oscillator. It is relatively immune to voltage changes and can be temperature compensated. Then an even better approach became apparent. How about a crystal oscillator?

Crystals at 29.75 chz are expensive. But a surplus FT241 crystal that is the 16th harmonic of 29.75 khz is easily and cheaply obtained. The crystal used in this generator turned out to be one marked "Channel 57, 25.7 Mcs", cut for 475.925925 khz. So, the final configuration of **Fig. 1c** evolved.

The 476 khz oscillator precedes a divide-by-sixteen stage. Then comes a divide-by-five or -seven stage, followed by a divide-by-two stage. The latter feeds the audio amplifier, followed by a low pass filter. The result: pure, stable, crystal-controlled mark and space tones.

Circuit Details

1. 476 chz square wave generator

NOR gates Gla and Gld **(Fig. 2)** form an astable multivibrator with a free running frequency slightly below 476 khz. Potentiometer **R1** controls that frequency. When

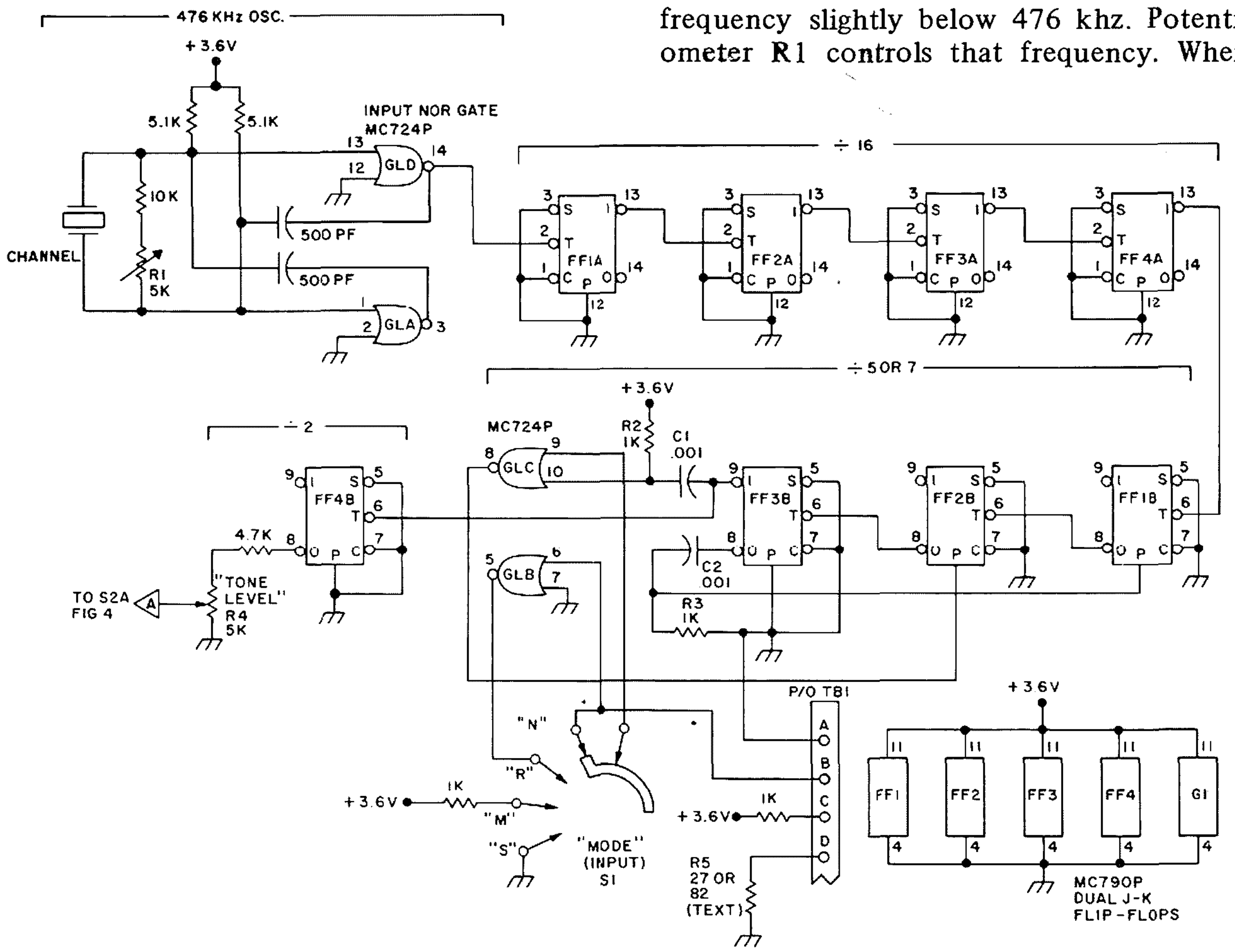


Fig. 2. Digital mark space tone generator schematic.

crystal Y1 is hung across the two inputs to the gates, it tries to synchronize the frequency to its own resonant frequency. Synchronization, of course, depends upon the free-running frequency, therefore, as R1 is varied, so is the frequency, by a slight amount. Of three crystals used, two allowed the multivibrator to synchronize at 476 khz with some adjustment range on both sides.

2. *Divide-by-sixteen stage*

A simple binary counter is assembled by the J-K flip-flops, FF1a, FF2a, FF3a and FF4a. It divides the input frequency by 16. Therefore, if the input is 476 chz, the output will be 29.75 chz. Although the more observant may note the counter actually functions backwards, this configuration was used for wiring convenience. Either way, forward or backwards, it takes 16 cycles of input frequency to get one cycle of output frequency.

3. *Divide-by-five-or-seven stage*

The heart of the AFSK generator is the divide-by-five-or-seven stage. The basis for this circuit was published originally by Donald E. Lancaster in the January 1968 issue of *The Electronic Engineer.* Lancaster demonstrates how to design counters to divide by any number. (Reprints of this article are available free from the magazine at P. O. Box 11081, Philadelphia, Pennsylvania, 19141.) Before detailing how this circuit is used, we should first review the Motorola RTL logic circuits. First the simple NOR gate: if any input is high, the output is low. If we use positive logic, (i. e. high voltage is 1, low voltage is Ø), a truth table for a 2 input NOR gate would look like this:

Inputs A	Inputs B	Output
0	0	1
1	0	0
0	1	0
1	1	0

The J-K flip-flop is more complex. Basically, it has three inputs and two outputs. Set, Clear and Trigger are the terms for inputs; outputs are Ø and 1. In the Ø state, the flip-flops Ø output is high and the 1 output low; in the 1 state, the Ø output is low and the 1 output high. To place the flip-flop in either of these states, various combinations of the inputs are used.

If both the Set and Clear inputs are at a logic 1 level, and a 1 level pulse is applied to the Trigger input, the flip-flop changes state,

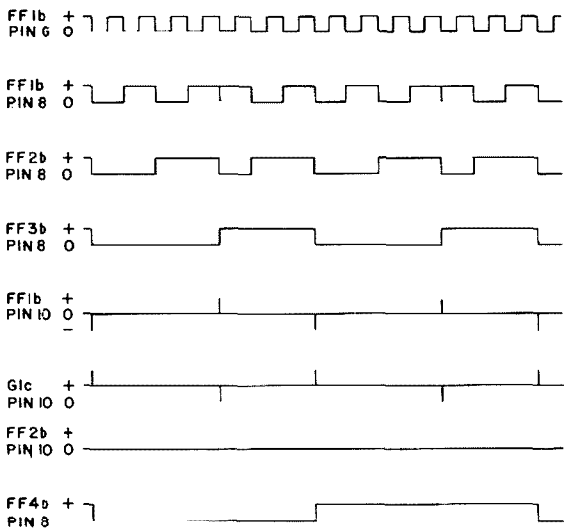


Fig. 3a. Mark condition waveforms.

or reverses itself. If the Set input is at a logic 1 level,and the Clear input at a logic ∅ level, and a logic 1 pulse is applied to the Trigger input, the flip-flop goes into the 1 state. If the Set input is at a logic ∅ level and the Clear input at a logic 1 level, a logic 1 level pulse applied to the Trigger input will induce the flip-flop into the ∅state.

Referring to **Fig. 2**, note that the Motorola RTL J-K flip-flops operate slightly differently. The S, T and C inputs as well as the ∅ and 1 outputs have little circles after them, denoting inverters. They invert the logic into and out of the flip-flop, thus converting a ∅ to a 1 and a 1 to a ∅. So, the truth table for the Motorola J-K flip-flop would look like this:

Inputs*		**Outputs****		
S	C	1	∅	State
∅	∅	Changes State		
1	∅	1	∅	∅
∅	1	∅	1	1
1	1	No State Change		

**Before Negative Pulse to T.*
***After Negative Pulse to T.*

So, if the flip-flop is in the 1 state, the output from the 1 output (after it goes through the inverter) is low, or a ∅ logic level.

The Motorola RTL J-K flip-flop has an extra input it calls "Direct Clear." This may be confusing since, if a positive pulse is applied to it, the flip-flop goes to the 1 state, regardless of the inputs to the other three input terminals. The Fairchild RTL series also uses this extra input, but terms it "Preset," which more accurately describes its function.

The divide-by-five-or-seven stage is formed by flip-flops FF1b, FF2b, FF3b and NOR gate G1c. Referring to the waveform diagram, **Fig. 3a**, observe how the divide-by-seven state operates. Basically, these flip-flops form a divide-by-eight counter. However, when the fourth input cycle is received, FF1b and FF2b go into the ∅ state, with FF3b going to 1 state. The positive going output from pin 8 of FF3b goes into the RC network R3C2, which is a differentiator. It takes in a square wave and produces a spike out, maintaining polarity. The positive spike out of the network feeds the Preset input of FF1b, placing it in the 1 state. Thus we have deceived the counter into believing it has received an extra pulse. From this point on, the counter again counts normally. This is the counting sequency:

000
001
010
011
101
110
111

Note we have skipped the 100 state and it takes only seven input cycles to get one output cycle.

Pin 9 of FF3b also has a differentiator following it, R2C1. When FF3b goes into the 1 state, it produces a negative spike out. This is fed to NOR gate G1c. However, since the other input to G1c is high during the divide-by-seven sequence, the output is always low. During the divide-by-five sequence, pin 9 of G1c is at a low level. Pin 10 as returned to +3.6 volts through R2, thus the output is still low.

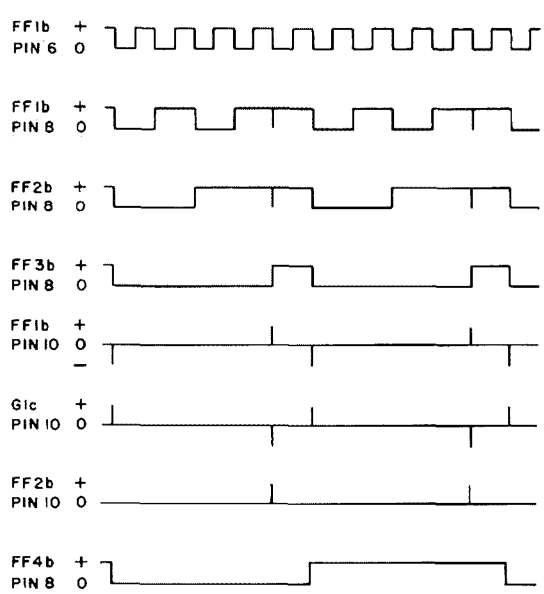


Fig. 3b. Space condition waveforms.

Examining waveform drawing **Fig. 3b**, we note that when FF3b goes into the 1 state, the negative pulse from R2C1 is fed into Glc. Since pin 9 of Glc is already low, when pin 10 goes low, a positive voltage appears at the output. Therefore in this divide-by-five state, Glc inverts the input to pin 10. The output from Glc is fed to the Preset input of FF2b. Now both FF1b and FF2b are placed in the 1 state, and the counter believes it has received 3 extra pulses. The counting sequence appears like this:

000
001
010
011
111

This time we have skipped the 100, 101 and 110 states and it requires only five cycles at the input to get one cycle at the output. It is the level at pin 9 of Glc which determines whether the counter divides by five or seven. Glb simply inverts the input level for reversed keying.

4. *Divide-by-two stage*

FF4b forms a simple divide-by-two stage. It takes the non-symmetrical square wave output from the divide-by-five-or-seven stage at 4250 hz, or 5950 hz, and produces a symmetrical square wave output of either 2125 hz or 2975 hz. This is then fed to the audio amplifier.

5. *Audio Amplifier*

IC1, an RCA CA3020 integrated circuit audio amplifier (see Fig. 4), accepts the square wave from the divide-by-two stage and amplifies it when the "Function" switch S2 is in the "AFSK" position. "Tone Level" potentiometer R4 varies the level of the square wave into the amplifier. When switch S2 is in either the "PTT" or the "voice" position, IC1 functions as a microphone preamplifier. The microphone is fed to pin 10 of IC1 which is the base of an emitter-follower. This follower's emitter is pin 1 of IC1 and connects to R6, the "Mic Level" potentiometer. The audio is then fed back into IC1 for further amplification.

The output impedance of IC1 is about 130 ohms. Matching was achieved by using two transformers, T1 and T2, with their voice-coil windings connected back-to-back. T1 is an Argonne AR-176 with a 125 ohm centertapped primary. T2 is an Argonne AR-164 with a 500 ohm primary. Both are available from LaFayette.

6. *Output Network*

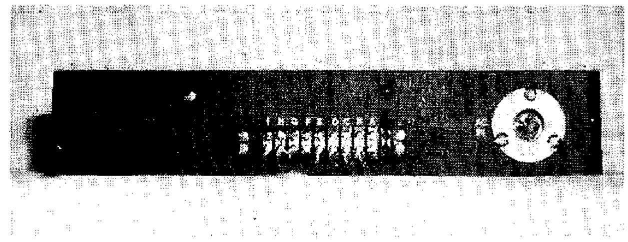
There are three separate stages in the

output network. R8 and R9 form a 500 to 430 ohm minimum loss pad. C3, L1, C4, L2 and C5 form a five-section Chebyshev lowpass filter. R10, R11 and R12 form a 430 to 600 ohm 16 db pad. The requirements for the lowpass filter led to this unique arrangement.

Since standard available inductors were to be used, the choice was confined to 11, 22, 44 or 88 mh. The filter had to be 40 db down at 6375 hz. A large pad appeared to be necessary to isolate the lowpass filter from the load since the primary impedances of various carbon microphone transformers might differ considerably. Since it was desirable to lump most of the loss on the output side of the filter, it should have an impedance near 500 ohms to minimize the loss in the input matching pad. Using 22 mh in the design equations for the lowpass filter resulted in an impedance closest to 500 ohms. It varies directly with the 40 db down frequency. Since the minimum 40 db frequency is 6375 hz, that figure and 22 mh in the equations came out to 433.5 ohms.

R8 and R9 match the 500 ohm output of the audio amplifier to the 433.5 ohm input of the lowpass filter. Insertion loss is about 3.28 db for this minimum loss pad. The lowpass filter is a five-section Chebyshev which means its skirt is fairly sharp, but it does have some ripple in the pass band. It is about 1 db and its 3 db point is above 3500 hz. At 6375 hz, it is 40 db down, and much more so, of course, at 8925 hz, the third harmonic of 2975 hz.

In computing loss through the lowpass isolation pad, it was determined that 4 to 5 milliwatts should be sufficient to drive most carbon microphone inputs. This figures out to about 20 db loss between the audio



Head-on rear shot. Only an engineer could label the terminals backwards.

amplifier and output. The input of the lowpass filter already shows a 3.28 db loss through the minimum loss pad. Therefore, about 16 db would be needed for the output pad. R10, R11 and R12 form this pad which also matches the output impedance of the lowpass filter to 600 ohms. Using standard value resistors, the loss actually comes out to 15.53 db. This produces a total loss of 18.81 db in the pads and between Ø and 1 db in the lowpass filter. Shorting the output, the filter sees 407.8 ohms; with an open circuit, it sees 454.4 ohms. The maximum variation between open and short is less than 6%, an excellent isolation.

Meter M1 is an illuminated miniature "VU" LaFayette meter, part number 99 h 5024. This is a "B" scale VU where Ø VU is 1.228 volts RMS, when used with the precision resistor supplied with it. This corresponds to +4 dbm across a 600 ohm line, or about 2.5 mw. The external multiplier resistor can be changed to display a Ø VU reading for other levels if desired.

7. *Power Supply*

The power supply (Fig. 5) is fused on the input side. T3 is a 6.3 volt, 1 amp filament

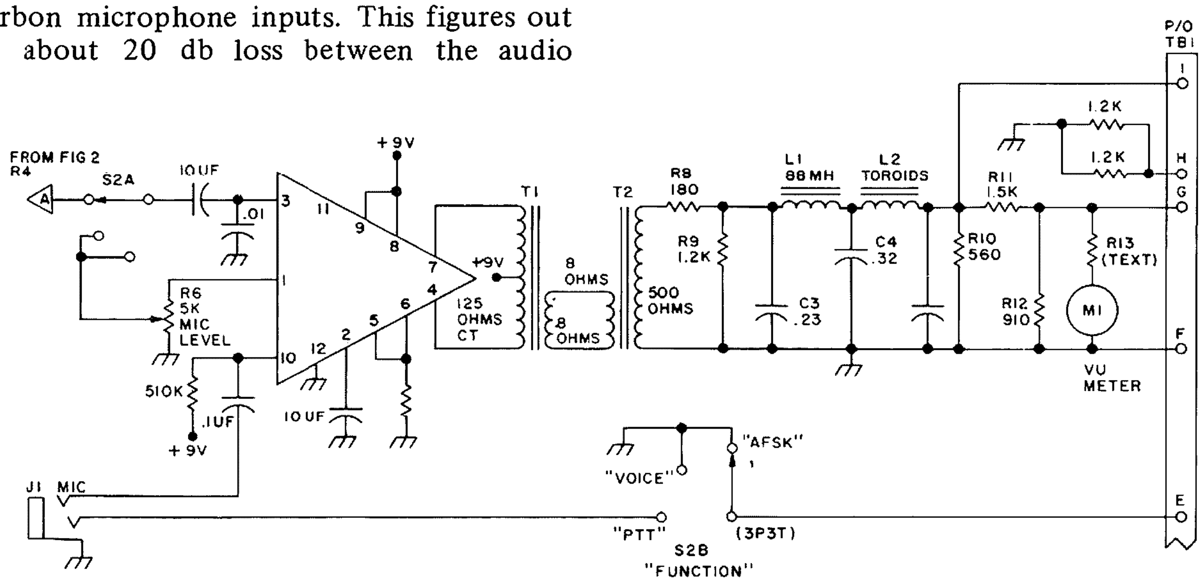


Fig. 4. Audio amplifier and output network schematic.

transformer. It is also fused on the secondary since a short probably would not

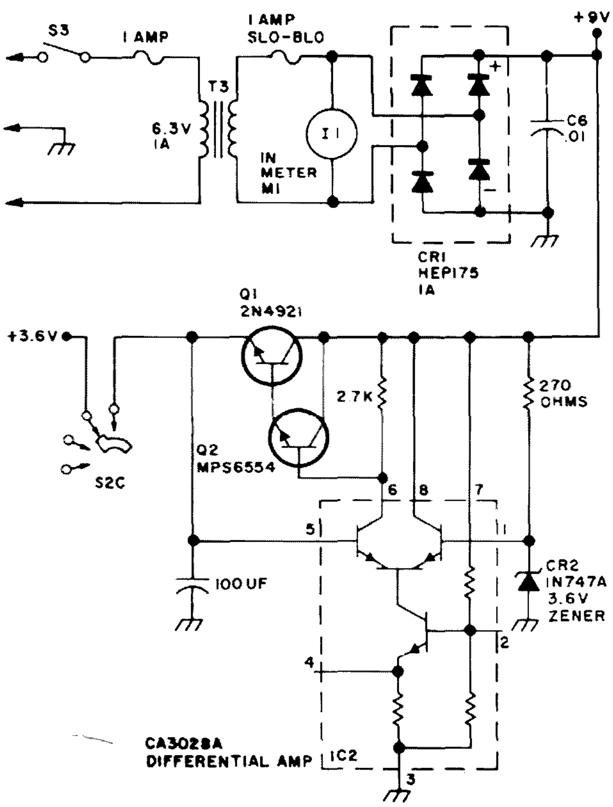


Fig. 5. Power supply schematic.

take out the primary fuse. A "slo-blo" is required because of the large peak currents drawn due to the large value of C6.

I1 is part of the VU meter, M1. CR1 is a full-wave bridge rectifier in a single neat package. C6 is a 10,000 mfd. (Correct: .01 farads!) 25 volt capacitor, available from Barry. Depending on load, the output is between 8 and 9 volts. Most of the voltage drop under load appears to occur in the transformer winding. Therefore, a huskier transformer should provide better regulation. Output powers the audio amplifier and the +3.6 regulator.

The regulator is required to supply +3.6 volts to the digital ICs. The voltage holds steady under varying loads and eliminates any residue ripples that might leak through C6. Diode CR2 is a 3.6 volt zener. This regulated voltage is fed to pin 1 of IC2, and RCA CA3028A. IC2 is a high gain differential amplifier. Its function is to compare the reference input on pin 1 to the regulator output on pin 5. The output is then fed to the base of Q2, connected to Q1 in a Darlington circuit. So, if the output is higher than the reference, the output on pin 6 of IC2 is lowered. This in turn reduces the base current to Q2 which lowers the base current

to Q1. This drops the output voltage on the emitter of Q1. The reverse process occurs if the output is lower than the reference.

Although fair regulation might have been obtained with zener diodes, there was doubt about their performance at low voltages. This regulator maintains output voltage changes to less than .1 volt and there are no ripple or transient problems. Even this small voltage variation might be avoided by using a larger primary power transformer.

Construction

Although the prototype was developed on a Vector 3477 DIPlugboard, constructors are advised to use standard unclad perf-board both for case of construction as well as to minimize coupling between the close-spaced etched leads on the DIPlugboard. This type of board also is susceptible to ground loops. It is advisable, even using standard perf-board, to use a common ground point for the bottom ends of R4, R6 and R7 and the ground ends of the bypass capacitors on pins 2 and 3 of IC1.

Particular care must be observed in shielding, since harmonic-rich *rf* square-

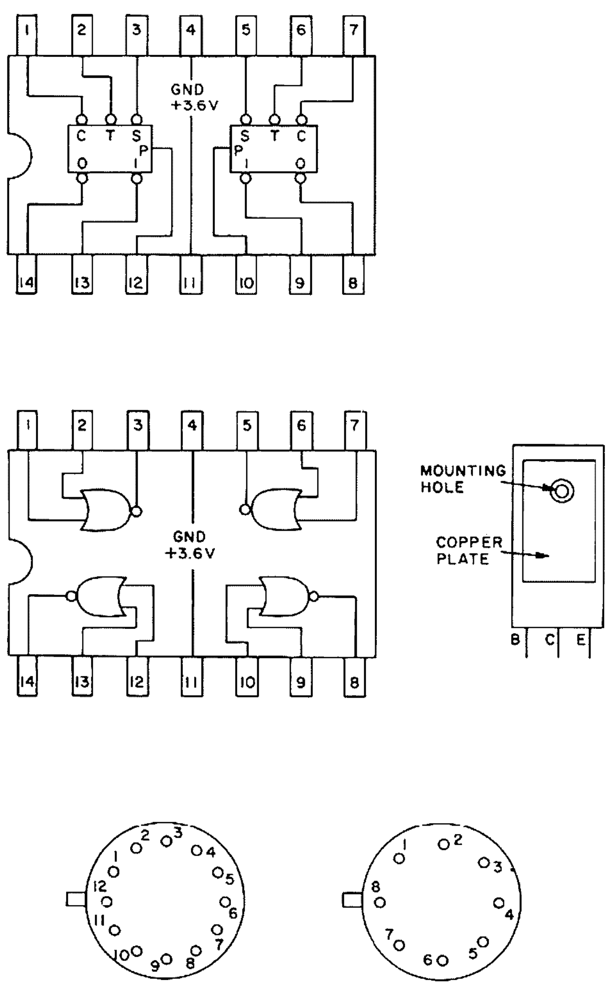


Fig. 6. Component basing diagrams.

waves are being generated. Use of an *rf* tight metal box is essential.

Fig. 6 should simplify identification in IC and transistor lead basing. Looking at the MC700P ICs from the bottom with the notch on the left, Pin 1 is on the left end of the top row of pins. The remainder of the pins are numbered consecutively clockwise, Pin 14 being on the left end of the bottom row. Viewing the CA3000 ICs from the bottom, note the little tab on the case. It is adjacent to the highest numbered pin, Pin 12 of the CA3020 and Pin 8 of the CA3028A. These pins are also numbered clockwise. The 2N4921, Q1, may be confusing. The case is rectangular plastic with three leads on the bottom and a copper plate on one side. There is a hole through it. Viewing from the bottom, with the copper plate up, the base lead is to the left, the collector in the middle, the emitter on the right. The leads for Q2, MPS6554 are marked on the case. Note that a heat sink must be used on IC1.

Alignment

Alignment is simple. Without connecting to the rig, jumper pin G to Pin H on TB1. This places a 600 ohm load on the unit. Place the S2 "Function" switch to "AFSK." Pots R4 and R6 should be at minimum. "Mode" switch, S1, should be in either the "M" (mark) or "S" (space) position. When turning on the power, I1 should light. At this point, check for proper supply voltages. Using the original multiplier resistor that came with M1 as R13, adjust R4 until M1 reads Ø VU. This interprets to about 1¼ volts across the output.

A frequency counter, if available, should be used for alignment. Check the output of FF1a at Pin 14. Adjust R1 until the output is exactly 238 khz – it's just as simple as that. If no counter is available, accurate mark or space tones, either off the air from an obliging ham or from a tape standard can be used. Place SI to the tone you are aligning against, M or S, and connect the generator output to a scope. Use the output at Pin I or TB1, since this is high impedance and compatible with most scopes. Put the standard tone on the other scope input axis and adjust R1 for a 1:1 pattern on the screen. When one tone is adjusted, the other is automatically on frequency. A third method of alignment is to use a 1430 khz broadcast frequency. (WNJR in New Jersey for the East Coast.) If an antenna is attached to the bc receiver and placed close to the 476 khz square-wave generator, you should

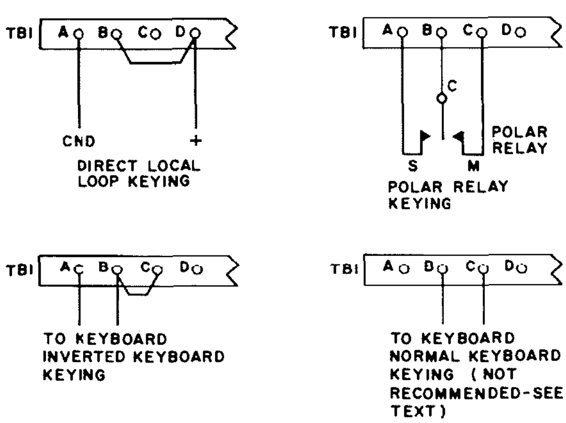


Fig. 7. Keying connection diagrams.

hear a beat note. This is the third harmonic of the generator and the 1430 khz signal. With the unit placed in the mark condition, connect the output to one axis of a scope. The audio of the bc receiver goes to the other axis. Adjust as described earlier for a 1:1 pattern between the beat note and the mark tone. This method may satisfy the purist since there will be a small amount of error. Actually the square-wave generator is producing 475.95840 khz and the Mark and Space tones are 2124.8143 hz and 2974.7400 hz, respectively. The maximum error is 0.26 hz!

Tuning of the low pass filter is a simple matter. No test equipment is required. The only value to be adjusted is that of C4. Start with a value of 0.22 uf. Then add capacity in steps of 0.001 uf until the Mark and Space tones are within 1 db of each other as indicated on M1. Now disconnect the jumper from terminals G and H of TB1 and you're ready to hook it up to your rig.

Operation

Three different methods of keying are provided. If the local loop supply is grounded and well-filtered, break it at the ground point and connect to terminal D of TB1. The loop ground goes to terminal A. Jumper terminals B to D. In this configuration the local loop runs through R5. For a 60 ma loop, R5 should be 27 ohms; with a 20 ma loop, R5 is 82 ohms. In the MARK condition with current flowing through the loop, about +1.6 volts appear on pin 9 of G1c with S1 in the N (normal) position. This serves to inhibit G1b and causes the unit to generate a mark tone. When the loop is open, or in the SPACE condition, Ø volts appear on pin 9 of G1c, enabling G1c, and the unit generates the SPACE tone.

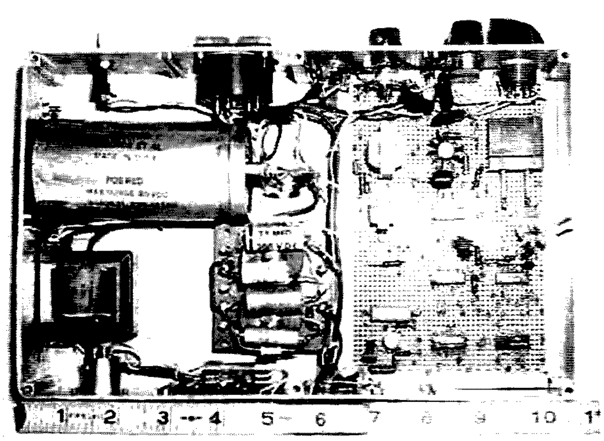
Polar relay keying is also provided by connecting the common to terminal B, the

mark contact to terminal C and the SPACE contact to terminal A. In this arrangement, Glc receives +3.6 volts through a 1 K resistor in the mark condition and a ground during SPACE.

Direct keyboard keying can be used by connecting terminal B to terminal C, and connecting the keyboard between terminals A and B. Although keying will be inverted, it can be corrected by placing S1 in the R (reverse) position. The keyboard could be connected between terminals B and C for normal keying, but this would result in the input line on terminal B left open during SPACE, but this could produce hum. The alternate connections are shown in **Fig. 7**.

It is assumed that S1 is in the N (normal) position in the preceding instructions. In the R (reverse) position, pin 9 of Glc is no longer fed from terminal B of TB1. It is now connected to the output of Glb, which takes the input from terminal B and inverts it. Therefore, the keying is inverted. In the M (mark) position, Sl connects the input of Glc to +3.6 volts through a 1 K resistor; in the S (space) position it grounds the input to Glc.

To apply the generator's audio output to the transmitter, any voltages connected to the primary of the carbon microphone transformer should be removed. Terminal G of TB1 should then be connected to the high side of the transformer and the low side to terminal F. Connect the PTT line to terminal E. With the transmitter in the stand-by condition, and the generator operating, placing S2 in the AFSK position should activate the transmitter. Advance the "tone level" pot to achieve approximate 100% modulation. Then select a value of R13 that



Interior bottom view. The diplugboard was wired by a dextrous midget. The bridge rectifier was mounted directly on the filter capicator to avoid ground loop problems. Note heat sink on IC1.

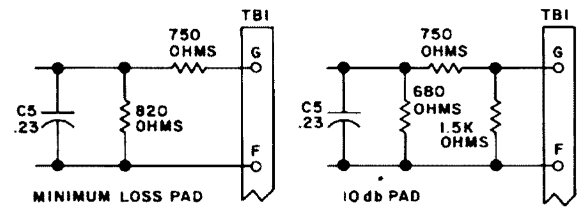


Fig. 8. Alternate output pad diagrams.

displays Ø on the VU meter. Then place S2 in the "voice" position and advance the "mic level" pot to produce about -3 VU while speaking normally into the microphone.

In the event the audio levels are low for your particular transmitter, it might be due to a mismatch between the 600 ohm output of the generator and the microphone transformer. This could be remedied by connecting a 600 ohm center-tapped transformer to the generator's output, and then hooking the microphone transformer between the low side and the center tap. We then have an autotransformer with a 600:150 ohm ratio. Or the carbon microphone transformer could be replaced with another unit with a 600 ohm primary.

If more output is desired and it is evident you have a 600 ohm load for the generator, the 16 db matching pad could be replaced with a 430:600 ohm minimum loss pad as shown in **Fig. 8**. This pad has about a 5.2 db loss, and the low pass filter sees slightly more than 0.5% error in termination when the output of the pad is terminated in 600 ohms. This should produce an added 10 db of gain, provided the unit is terminated at 600 ohms. Or the 16 db pad could be replaced with an alternative 10 db pad shown in **Fig. 8**. The gain in this instance is about 6 db in the output, but care in the termination value must be observed. Going from short to open circuit makes the low pass filter see a variation of about 20% from its design impedance. This is much greater than the 6% variation with the 16 db pad.

Still another method of obtaining more gain is to short out R7. This raises the current drawn by the amplifier and may increase distortion. Or Pin 11 or IC1 could be connected to the +9 volt line through a 1.5K resistor. However, these alternatives may lead to amplifier instability, since the 3 db point of this little IC is about 8 mhz with a resistive load. It is usable up into the vhf range with tuned loads.

Various modes of keying were tried in on-the-air testing of this unit. While all

appeared to perform normally and, as anticipated, scope patterns and analyses at the receiving ends indicated that the polar relay method produced the most accurate keying characteristics. If a relay is used, be sure that it is a well adjusted polar relay. This unit will follow keying up to near a 4 khz rate. Any contact bounce will be faithfully reproduced by the unit. In all modes, there was favorable comment on the purity of the tones as well as their accuracy. Even the most exotic commercial counter was only able to detect a 1 hz variation on either Mark or Space.

Although there is an evident mismatch between the audio unit and the carbon mic input transformer of the transmitter, there was no evidence of insufficient drive to the rig's audio amplifier. No appreciable improvement was obtained using various external transformers, although any arrangement which can provide less than a 2 or 3 to 1 mismatch is desirable. Although the microphone is not used on the RTTY frequency, the same rig is switched to other 2 meter frequencies, so the unit can be left connected to the transmitter at all times, and the microphone is available for use whenever desired.

Since this unit was constructed, RCA has come out with the CA3020A and the CA3028B, newer editions of the linear ICs used in this unit. No circuit modification is required to use these later versions, and almost 3 db more gain is available in the CA3020A than in the CA3020.

Conclusion

As one operator observed after listening to this device on the air and learning of its design and construction: "That's a helluva complicated way to get a couple of simple tones." And so it is. However, for the experimenter who wishes to increase his familiarity with ICs and develop new techniques in obtaining standard results, working with these devices should be both challenging and rewarding. It is also a source of pride to this operator to assure others on the RTTY net that our tones are unchanging "on the nose" standards.

I would like to thank my father, KØREC, who put his not inconsiderable editorial talents to work, translating engineerese into English. He also performed the on-the-air tests, since I am not presently on the air, due to the fact that my father has my model 15 and won't relinquish it.

. . . W1ESH/3

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Transistor Transmitter Aspirin

or how to keep things from going pffft!

I am sure many have experienced the tragic "blowing" of a transistor (sometimes costly) and weren't sure what caused the darn thing to blow.

Some quotes from RCA's application sheet SMA-40 plus my own experiences may help many of you to save a few transistors.

How many of you have built a transmitter and, with dummy load connected, power on and even a current meter or two in the supply circuits, pull out the crystal and the darn thing still puts out *rf*? Or, sometimes when a stage 'is just on the verge,' it needs a little "tickling" or slight amount of drive to put stage into oscillation (usually the final, but not always). This latter type of trouble will disappear when the crystal is removed. This can cause thermal runaway and many times open or short the junction without you being aware by noting current meters.

As the RCA manual states: A transistor having a power gain of 5 at 174 mhz may have a power gain of 30 at 10 mhz. That doesn't seem like much, but wait, that's around 8 db stray inductance (even portions of the printed circuit board) plus stay capacitance, *rf* chokes and by-pass capacitors may make the 50 mhz (or any band) take off wildly at a lower frequency, and sometimes could be at a higher frequency if circuit components are just right.

Use of low Q ferrite chokes or even a wire wound resistor (that's right) in the base and collector load circuits with emitter (if not grounded) and supply leads by-passed with two capacitors, one for low frequency and one for frequency being used, plus very short leads and a design that will permit one ground per stage will help. Roughly, a .001 mF capacitor will have three ohms reactance at 50 MHz and 16 ohms at 10 Mhz, and 31 ohms at 5 MHz. With even one watt of power, a few tenths of a volt could develop across this reactance and, by a sneaky way known only to itself, could get into other circuits and make them go wild. Believe it or not, but with a homebrew peak *rf* voltmeter on my two transistor 125 mw rig, from the emitter connection on the socket back to the main ground run, about 3/8", I measured .15 volts. I laid a piece of #14 wire along this 3/8" stretch and soldered it, using as much solder as wire to make the lead very low resistance. So in printed circuits, lay wire or better, small strips of copper or brass and solder all along the way. It will lower the resistance path. After you get over a 100 or so milliwatts, I would strongly urge you to forget printed board and go to metal chassis.

On my printed boards, if at all possible, I try to leave a strip clear around ¼" wide of the copper plus strips from one side to the other where I plan to solder a shield, and if you don't use wire or strip brass, coat all printed board with solder to lower the R and Z.

Even using low Q chokes of bigger wire and adding a 33 to 47 ohm resistor as shown in Fig. 1 will help to cure some of the ills. Don't forget the by-pass C.

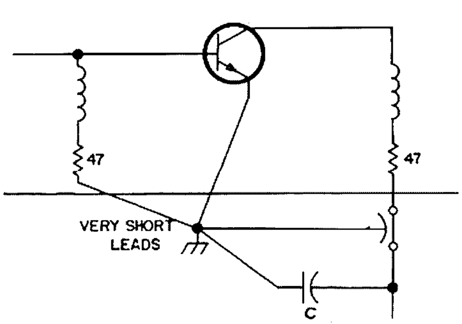

Fig. 1. Circuits can be tamed by proper VHF grounding.

I have had the experience in tuning up the driver and the final, of seeing the dummy load brighten up as expected and then suddenly drop down. I was at a loss to explain this till RCA cleared it up for me. It would also clear up the downward modulation when it shouldn't have been downward. The base/collector junction (especially of overlays) capacitance changes with applied voltage (or drive on the base). You have a varactor or varicap diode here that can detune your circuits! I bet this answers why to some of you! Using common emitter circuits and just enough drive to fulfill the job (like in the 2½ w transmitter, I state I can tune up to three watts but 2½ is stable and it rides there) and possibly a little higher L to C than before, in the tuned circuits.

I would strongly urge all you who are interested in solid state transmitters to buy RCA's "RCA Silicon Power Circuits" and write and request from RCA their Application sheets #SMA 36 (Design of Large Signal VHF Transistor Power Amplification) and #SMA40 (Frequency Multiplication Using Overlay Transistors). In fact, most of the others that make transistors will send you application sheets dealing with the subject you are interested in. They also have some good notes (and lots of math) on matching networks; matching from one stage to another and matching from final to antenna. Easy? Well, try matching a transistor collector of a few ohms impedance to several hundred ohms impedance to a circuit that will have some Q and will tune (without being shorted out or swamped by the transistor) and match this to a 50 ohm antenna.

A regulated power supply is a must (or batteries). You can imagine several hundred mills being pulled by the driver and final and several hundred in the modulator (assuming high power here, but it's the same with a 100 mw rig and a flea power supply) at voice peaks and how the voltage would swing madly everytime the thing was modulated. This will cause downward modulation, FM'ing, oscillator pulling, plus many other weird troubles.

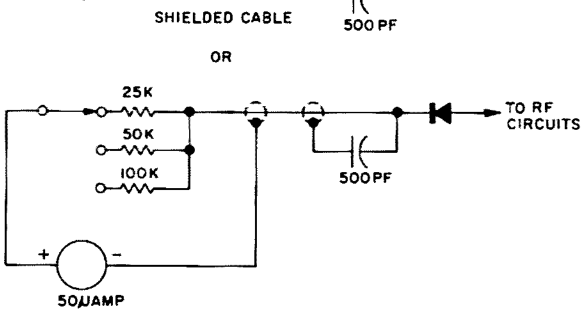

Fig. 2. Meter for finding ground loops.

Fusing the power supply or the supply leads to various stages can help. Mostly when a transistor goes bad, except in thermal runaway which may start slowly and end fast, fuses can't blow fast enough to offer too much protection, but now and then they may help!

If you have the habit of connecting the rig up backwards especially after playing around with both PNP's and NPN's transistors, connect a diode (50 mill to 1 or more amps depending on circuit) in series with supply leads in the right polarity that will give you the polarity wanted and by-pass it well. Now reverse the supply and you can do no damage, if done right.

In Fig. 2 is a meter that is very helpful. You can tell if the following stage is getting drive and if there are ground loops causing *rf* voltage drops. You can use your multimeter here with a probe. In this case you will be reading RMS values, but my meter has a scale of 0-1 so I use it as a relative meter just to tell me if I've got it, or if I haven't. If I can get a good indication on the lower scale from one point to another on chassis ground, I try to correct or lower it fast.

As stated in another article, I couldn't put the transmitter and modulator in the same case in spite of shielding. Always try it out breadboard, as it sure is work to tear it partly down and redesign and rebuild. I prefer separate modulators, then I can use it on other transmitters also.

Use heat sinks, preferably the finned types, and bigger types in larger powered rigs. Don't be greedy for power. In my 125 mw. rig, I went to 16 volts and under modulation the oscillator transistor "went west." If you design for 9, 12, 16, or 28 volts – stay with it. If you want more power – build for that power!

Last but not least, and very important, use a dummy load or antenna on your rigs as you test them. If not, where do you think the power (you hope to go into the antenna) is going? Mostly heat and ruined transistors!

...KØVQY

(... de W2NSD/1 continued from page 2)

TAG members, with a SASE for the answer. This is a wonderful opportunity to help some newcomers over the first hurdles.

If you are a member of a radio club that will welcome neophytes and help them on the road to becoming a Novice, then please send in the name of the club and the address so we can pass it along through the magazine and try and get you new members.

We are wide open for any suggestions for articles or services that would be of value. We need more amateurs and we need them desperately . . . I am hoping that the new magazine will help.

Articles We'd Like to See

International Crystal has a set of transistorized circuits on pc boards that have sparked a lot of building. Their crystal oscillator board sells for only $2.95 and is available in 3-20 mhz or 20-60 mhz models. I'll bet that you could put one of these down on 455 khz easily by changing the coil and use it for a bfo. The *rf* amplifier unit is $3.50 and is available in 3-20 or 20-170 mhz models. The mixer unit is available in the same two ranges at the same price. For $3.75 you can get a broadband amplifier unit that can be used for audio or, with *if* transformers, as an *if* amplifier. It will go from 20 hz right up through 150 mhz. There is also a power amplifier available at the same price for the 3-30 mhz range, designed to follow the crystal oscillator and give you up to 200 mw output.

More people will have fun with these units if you will send in articles showing them in application. They should make a 2M receiver rather simple to make. I'd like to see fifty articles on different uses for these interesting and inexpensive transistor units.

Another field that is interesting more and more amateurs is the burglar alarm problem. There are a number of commercial units appearing on the market as the crime rate skyrockets, but I'll bet that many of you look at them about the same way I do. I'd like to have a good alarm system, one that would warn of fire, smoke, or intruders, but I can't see buying one of those extremely expensive commercial units. It seems to me, that as the resident electronics expert, I should be able to come up with something more of a ham nature and with a ham price tag on it to do the job.

Have any readers worked out some alarm systems for their homes or cars which might be of value to the rest of us? Have you found any alarm components which are available at ham type prices which we should know about? Have any of you worked out any simple sensors for heat or smoke? Hundreds of mobile rigs are being swiped every year and we all should have an alarm system of some kind in our car. And, if your wife is like mine, a home alarm would help her sleep a lot easier.

Far too few FM articles are being submitted. This is one of the fastest growing areas of amateur radio at present and I would like to see a lot more articles on it. We need more information on setting up remote repeaters and operating them. We need articles telling us what areas of the country are covered by repeaters. We need articles on tests of some of the new FM transceivers that are being made for ham use. We need articles on antennas for FM. Anything that is of good general interest to all amateurs is worthy of being published . . . let's go.

New Typesetting System

IBM has just installed their new MT/ST taped typesetting equipment for us and we are having fun getting used to that kluge. With this arrangement we set the type by typing it up on a regular IBM Selectric typewriter. As this is typed it is recorded on a magnetic tape. Then we put the tape into the print-out unit, set the width of the margins we want, and watch it go. Other than stopping for us to change type faces or for a line that has to be hyphenated, it just zips along.

This contraption costs like the devil, but with the plans for the new magazine this winter, we'll be needing the extra speed.

If any readers have any MT/ST tapes available reasonably, we sure could use an extra supply of those. I hate to drive IBM stock up any more than I have to.

Cars

Whenever I meet readers at conventions or

at ham clubs I am invariably asked about my Porsche. It has been some time since I have written much about my cars. Believe it or not, but I still have my old Porsche . . . the one I bought in 1957. This is the old Speedster model which they discontinued shortly after I bought mine. I've tried a couple of newer models since then, but I haven't found anything that I like nearly as well as the old Speedster. It is lower and more open than anything newer, and handles like a dream.

Last fall Lin and I made a short trip to Europe and picked up a Rover 2000 TC sedan. I'd been thinking about this for a couple of years . . . ever since Jean Shepherd K2ORS began talking it up on his radio program over WOR in New York. The review in *Car and Driver Magazine* finished me off and we got one.

What brought this all to mind was a little experience I had during my visit to Des Moines and the ARRL National Convention. I went out to dinner with a heck of a nice ham and his wife . . . Iowans. He said that he didn't enjoy driving. Well, I enjoy driving. I love it. But this didn't start until I discovered that there is one tremendous difference between cars. The Porsche woke me up to how much fun could be had with a really responsive car. Now, every time I take the Rover out, even to the store, I marvel at how it handles . . . how comfortable it is . . . how much fun to drive. It buzzes along at 80 and 90 with the same comfort that I find in the Sporty US cars at about 40. It holds the road through the sharpest of curves a lot like the Porsche. The leather seats are more like my living room chairs than a car.

Every time I go on a trip and have to rent an American car from one of the rental companies I get more and more depressed with the American product. I haven't found one yet (and I think I have tried almost everything now) that I would ever trade for my Rover . . . and it cost only a little over $3000.

Get mad at me if you will for telling you about my Rover, but whenever I find something that gives me as much pleasure as that car, I feel that I have a responsibility to tell you about it.

Microwave Oven

One of the big excitements of the 73 exhibit at the Boston ARRL Convention was a great big bowl of free hot dogs. "Food For Thought" was the heading. We set up one of the new International Crystal Microwave Ovens in our booth and turned out red hots for the crowd. The oven is a ball to use. It turns cold franks into juicy hot dogs in about 15 seconds.

Lin and I have been having a lot of fun with the oven at home too. What a difference it makes to be able to have baked potatoes with any dinner in a matter of about five minutes instead of running the hot stove oven for 45 minutes or so. Baked apple? About three minutes is all it takes, so I have them for lunch or even an afternoon snack now, freshly baked. Bacon comes out tender and juicy in 30 seconds. Frozen rolls take half a minute. Tender hot croissants take a few seconds for breakfast, ditto most any of the packaged rolls and cakes. Leftovers can be warmed in seconds right in the plastic refrigerator boxes. Hot coffee or chocolate takes seconds. Hot sandwiches, too.

Frozen vegetables can be defrosted and cooked in a couple of minutes. Frozen meats can be defrosted quickly too, though we prefer them cooked the regular way most of the time. Since it cooks from the inside it is great for sausages, but beef seems a bit different this way. It does warm up slices of roast beef deliciously in ten seconds though.

The oven costs a little under $600, which really isn't bad for someone who loves to cook. Once you have one, you will use it a dozen times a day. *(continued on page 136)*

Improvement of Phone Intelligibility by Base Clipping

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Shortly before the beginning of World War II, a number of operators and experimenters discovered, more or less independently, that phone signals, made unintelligible by noise, could be "cleaned up" and made more intelligible by base clipping. Theory of operation of the base clipper, as it was outlined at the time, is shown in **Fig. 1**. This theory was later proved to be somewhat incorrect, yet base clipping demonstrably improved the intelligibility of received phone signals. As originally outlined, if a signal (A) and a noise (B) were both present in an audio circuit, the resultant combined signal (C) could be "cleaned up" by eliminating all parts of it from +N to -N, giving the improved signal (D). The rounding off of the zero-crossing "step," caused by base clipping, occurred in later stages of amplification. A recent base-clipper circuit, using this principle, has been outlined by Shelby.[1]

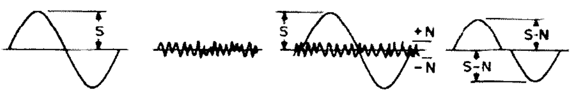


Fig. 1. Preliminary (and incorrect) theory of base clipping.

Although oscilloscopic studies of audio signals showed that the noise signal was added to the audio signal, so that this theory was definitely incorrect, I made and used several base clippers with gratifying results from 1946 to 1960. These consisted substantially of a phase inverter, followed by a push-pull amplifier, with a wide range of bias adjustments, so that it could be operated in any class from A to C. Using this device, there was a point of optimum intelligibility for any signal, this point being toward class A operation with clean signals, and toward class C operation with signals mushed by noise. A variety of biased series diode circuits were also used, in conjunction with pre- and post-amplifiers, to perform the same function, and they worked about as well as the variable class audio amplifier.[2]

Checking of the base clipper operation with a good oscilloscope corrected the original erroneous theory of operation, and finally showed just how the noted signal improvement came about. Referring to **Fig. 2**, if we feed an amplifier with a signal (E) and a noise (F), the resultant output will be the mushed sine wave (G). Clipping the base of this curve at levels +N and -N will produce the curve (H), and no detectable improvement in tone quality. With continuous sine waves, base clipping does not improve signal quality. However, with wave trains, such as a CW signal, base clipping at the level of the average noise (or slightly higher) does produce a definite improvement in readability, as in **Fig. 3**, and this is still further increased if base clipping is followed by peak clipping. Wave envelope of a noise-free CW signal is shown in **Fig. 3**, (I). To this is added noise (J), producing the output (K), a combination of signal and noise. The signal plus noise-to-noise ratio here is poor. By clipping the base at a level equal to or slightly exceeding the noise, envelope (L) is produced, with a greatly improved noise ratio. If this signal is now peak-clipped,

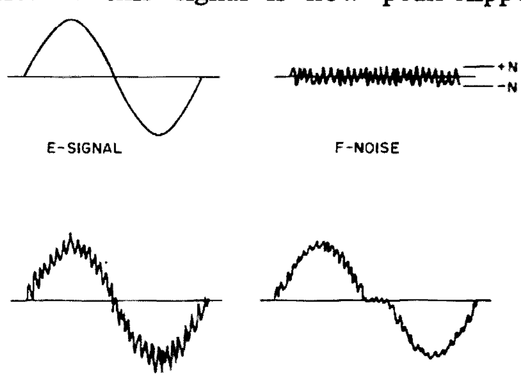


Fig. 2. Behavior of sine-wave signal in the presence of noise.

envelope (M) will be produced, which is almost "pure" signal.

If, now, this output is rectified and filtered, it can be used to key an audio oscillator, the combination being known as a "code regenerator."

This still does not tell how base clipping improves the quality of received speech, but *"Eppur si mueve."* Oscilloscopic studies with sine waves and CW signals, however, do disclose a key fact: with base clipping at the no-signal noise level, where there is no signal, there is also no noise.

Further oscilloscopic studies of actual speech signals, plus some excursions into physical linguistics, greatly assisted by published researches of the Bell Telephone Laboratories, finally gave a very satisfactory answer, which is outlined in **Fig. 4**.

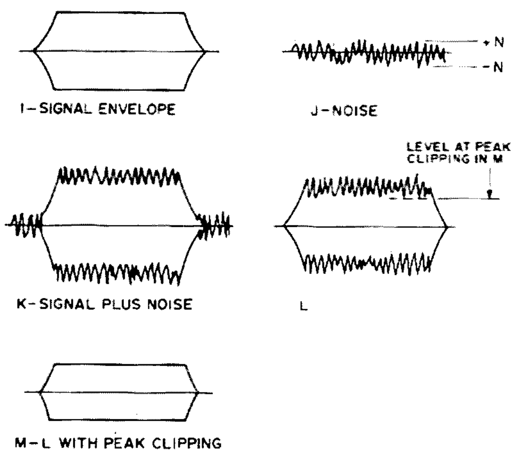


Fig. 3. Improvement of CW signals by base clipping.

Speech, basically, consists of an audio carrier, of varied frequency content, modulated in a rather specific fashion. The "carrier" frequency is not too important, as we can understand the spoken words of a "Russian" bass and of a "screeching" soprano with almost equal facility, all other factors remaining the same. The shape of the modulation envelope, however, is quite important, particularly the phonemal pauses, which are intervals of no signal occurring at the ends of syllables, and as a part of certain labial and lingual phonemes (the building blocks of speech). If the phonemal pauses are clearly defined, the diction is said to be good; if the phonemal pauses are not clearly defined, diction is called poor. Intelligibility of speech, in very general terms, is a function of the quality of the diction.

A speech envelope is shown diagrammatically in **Fig. 4** (N), with the phonemal pauses indicated by X. Noise is shown at (0),

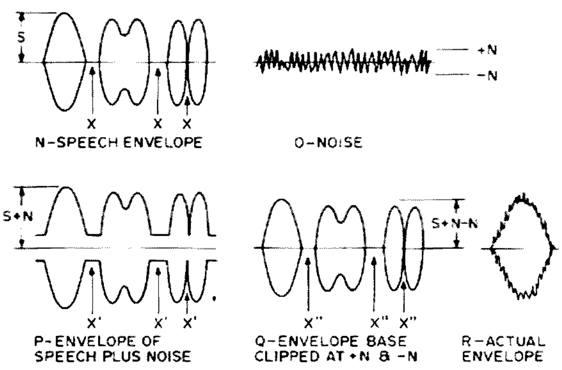


Fig. 4. Improvement of speech intelligibility by reduction of masking noise.

and signal plus noise, as received, at (P). Note here that the phonemal pauses, indicated by X, are plugged up, so that diction is degraded, as is intelligibility. This situation, which you can duplicate by connecting an oscilloscope across your receiver output while listening to a phone signal on "one of those nights," almost exactly parallels the "masking noise" situation so thoroughly studied by Harvey Fletcher.[3] If, by base clipping at the average level of the noise, we clear up the phonemal pauses, signal intelligibility is greatly improved, and the signal envelope now looks like (Q) in **Fig. 4**. The effect is quite similar to that produced by increasing the percentage of modulation. A still greater improvement is indirectly brought about, in the case of "white" noise, because a low frequency will tend to "override" a sound of higher frequency. Although noise above the clipping level is still superposed on the signal envelope, as in (R) of **Fig. 4**, the human ear will tend to disregard the higher frequency, and respond to the lower, through a wide range of signal and noise intensities. This also has been studied and reported in detail by Fletcher (op. cit., p. 153). This same line of reasoning points out the need for keeping hum at a minimum, and explains why a measured low level of hum has a high perceived level of annoyance.

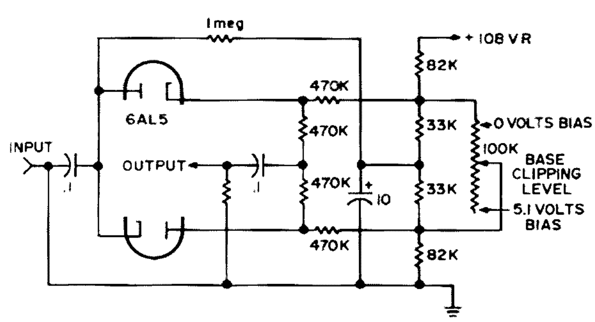
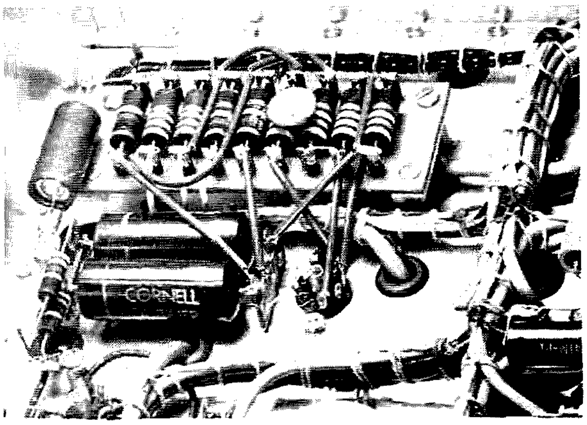


Fig. 5. Earle threshold modified for base clipping.



Under-chassis view of base clipper using modified Earle circuit.

Methods of base clipping have been greatly improved and simplified during the past few years. One of the best base clippers now known is derived from a circuit developed by W. A. Earle.[4] This, shown diagrammatically in Fig. 5, consists of a biased dual diode in series with the signal line, diodes being in opposed polarity. Since both diodes are cut off by a bias, which can be varied from zero to more than five volts, a signal applied at the input will not pass through the diodes until its peak amplitude exceeds the bias. When the signal peak amplitude does exceed the diode bias, all excess signal voltage reaches the output through a 470 k resistor. Thus, any signal may be base clipped at any desired value from zero to about five volts. Insertion loss of the base clipper, at zero bias setting, is about 6 db (measured).

Experiments with various semiconductor diodes in place of the 6AL5 dual diode indicates that a wide variety of high back resistance germanium diodes will work very well, the "toe" of their characteristic being unimportant under normal operating conditions.

Silicon diodes are slightly less applicable, as their toe is at approximately .6 volts. This can be offset by a complex biasing arrangement and becomes less important when signal amplitudes are high.

Tests show that the base clipper is usually most effective when connected between the first and second audio stages, as in this position, the noise voltages which it is desired to eliminate are within the normal range of adjustment of the clipper, and all usual adjustments will be within the reasonably straight portion of the diode characteristics.

Unlike many audio filters and clippers, this type of base clipper is easy to build, and requires no special adjustments or tricky "diddling" to make it work. All fixed components except the 6AL5 are mounted on a conventional terminal board, and all signal wiring is point-to-point. For reasons of stability, 2 watt 5 percent carbon resistors were used, although current in circuit would permit use of ½watt resistors. Leads to the 100k level control resistor, mounted in the panel, are shielded microphone cable, to prevent hum and unwanted coupling to other circuits, and a .02 μf ceramic capacitor is connected across the control to reduce contact noise. Filament of the 6AL5 is biased +40 volts with respect to ground, to prevent hum injection, and this is as effective in this application as pure dc on the filament.

For operating convenience, the base clipper was switched in and out of circuit by means of a relay, which is controlled by a switch on the level control. When base clipping bias is at zero, the base clipper is automatically switched out of the circuit.

In operation, with the base clipper out of the circuit, tune in the desired signal, and adjust all controls for the best intelligibility possible without the base clipper. Then switch in the base clipper, and adjust bias for best reception. This will occur when the phonemal pauses in the received speech are substantially clear of noise. Additional base clipping will not, in most instances, bring about any further improvement in intelligibility, and too much base clipping will turn most speech into gibberish.

Experimentation with base clippers also explains, in part, why some operators who have obvious hearing impairments ("tin ears") seem to copy about as well under almost hopeless conditions as they do when conditions are good. They have a built-in base clipper!

. . . Ronald L. Ives

1 Shelby, E. F. "A QRM Killer", *CQ,* Vol. 21, No. 9, Sept., 1965, 30 et seq.

2 Ives, R. L. Improved Base Clipper, *73,* Vol. 12, No. 1, Oct., 1962, 20-21.

3 Fletcher, Harvey, *Speech and Hearing in Communication*, New York (Van Nostrand), 1953, 153-175.

4 Earle, W. A. "A-C Threshold Converts to Switch", *Electronics;* Vol. 31, No. L, Jan. 3, 1958, 98-100.

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Measurement of Meter Resistance

It is often necessary, when building any sort of equipment using a sensitive meter, to know the internal resistance of the meter. The obvious way of measurement – simply slapping an ohmmeter on it – is not safe, because most ohmmeters, when switched to a range which will read the comparatively low meter resistance, will pass a high enough current through the meter to damage it.

The following method, though old, is not widely known. It uses the meter itself as the indicator. The meter is connected to a constant-current source, that is, a voltage source in series with a suitably high resistance. A variable resistance is then connected right across the meter terminals and adjusted to take exactly half the total current. The variable resistance is now equal to the meter resistance and may be removed and measured by any of the usual methods.

For a practical circuit see **Fig. 1.** The voltage source may be anything handy, even a 1.5 volt dry cell, though a higher voltage will give more accuracy. The total resistance R1 plus R2 is calculated by Ohm's law to allow full scale current to flow through the meter. *Don't* make a mistake in this calculation and pass 10 or 100 times too much current! If in doubt, start with too high a resistance and work down. At least 2/3 of the resistance should be in the fixed resistance R1, so that accidentally cranking R2 to the wrong end will not injure the meter. Also, connect the battery up last, after everything else is ready.

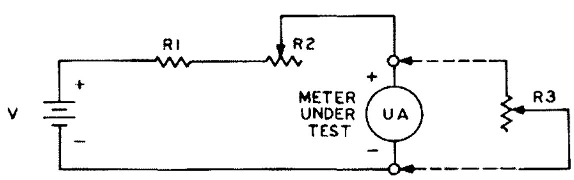

Fig. 1. Circuit for measurement of meter resistance (see text for values of R1, R2, R3 and V).

Having set R2 to make the meter indicate full scale, connect another variable resistor R3 across the meter terminals and adjust it to make the meter indicate exactly half as much current. Now, without disturbing the setting of R3, remove it and measure its resistance with an ohmmeter.

An example may make things clearer. A 0-100 microampere meter out of our junk box will be measured using a 1.5 volt dry cell as the voltage source. The total resistance will be 1.5 volt divided by 0.0001 ampere (watch the decimal point!) or 15,000 ohms. R1 can conveniently be 10,000 or 12,000 ohms, and R2 a 5,000 or 10,000 ohm potentiometer. Connect them up as shown in **Fig. 1**, and set R2 for full scale indication, 100 microamperes.

For a first try, a 1,000 ohm potentiometer can be used for R3. Connect it across the meter as shown by the dotted lines in **Fig. 1**, and adjust it to make the meter indicate 50 microamperes. Now remove R3 and measure it; let us suppose it turns out to be 500 ohms. We can then say that the meter is also (almost exactly) 500 ohms.

Note that connecting R3 reduces the total resistance in the circuit slightly, so that in our example the total current flowing would not stay exactly at 100 microamperes. If the meter resistance is 500 ohms, connecting R3 would reduce the resistance of the meter-and-R3 combination to 250 ohms. The resistance seen by the battery would drop from 15,000 to 14,750 ohms, so

that the current is not 100 microamperes now, but 101.7. This means that R3 is carrying 51.7 microamperes and will turn out to be 484 ohms, which is low by about 3 percent. This amount of error is not objectionable in many cases, and can be reduced by using a higher voltage source with correspondingly larger R1 and R2. There is not much point in trying to reduce this kind of error below 1 percent, since the accuracy of the ohmmeter and the scale linearity of the meter being measured are not likely to be any better than this. Putting it another way, it will rarely be necessary to use a source over 4.5 volts to keep the current acceptably constant. On the other hand, the voltage source may be as high as desired, except for the shock hazard and the fact that R1 and R2 will get inconveniently large.

The value of R3 will depend on the meter range. Most 0-1 milliammeters will be between 25 and 100 ohms, and microammeters will be higher, up to perhaps 5000 ohms for the most sensitive ones.

Go to it, but be careful. Any time you mess around with a meter and a battery, one mistake is all it takes.

... WA6NIL

Diode-Stack Power Supplies — The Easy Way

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Many amateurs wish to have quick-start transmitters with reduced heat during standby periods. This leads to thought of the possibility of replacing rectifier tubes with diodes in high-voltage power supplies.

The first approach generally is to look for a hatful of 800-volt or 1,000-volt diodes with a current rating somewhere between 750 ma and 3 amperes, and to plan for an equal number of capacitors and resistors to go across them. The result is an impressive installation. Some, like Fred Mason, KH6OR, had a failure before the number of series elements was increased to provide an adequate safety factor.

There are some direct tube replacements, such as the Sarkes Tarzian S-5130 used by W4PR, and by W6RT in the Collins 30-S1, with a protective device added, but this unit is listed in the mail-order catalogs at $22.50 each. They are rated at 10,400 inverse peak (7400 rms) volts; and at 300 ma continuous, 3000 ma peak, current. For a capacitive load, the current should be derated by 20 percent and the rms input voltage by 50 percent. This cuts the rating very thin when one unit must stand the full voltage of a center-tapped transformer. The current rating is less of a problem due to the low duty cycle for single-sideband transmitters.

I wanted a simple solution for my Henry 2K amplifier, without any modification, if possible. The 3B28 tubes are in front where they get some air circulation from the blower intake. There is space above the sockets. The matter was discussed with Frank Clement, W6KPC, of Diodes, Inc., 9261 Independence Avenue, Chatsworth, California. This resulted in the purchase of four No. 5244 high-voltage diode stacks at about $8 each.

These can be used two-in-series on each leg of a center-tapped transformer, or singly in the conventional bridge circuit producing the same output. Each stack is rated at 6,000 volts peak and ½ ampere continuous duty when fastened to a heat sink. They have stood up when drawing 800 ma, key down, during tuning using a dummy load. They will tolerate a 50-ampere "in-rush surge" if it is not longer than half a cycle.

The heat sink should be the chassis, or a plate with about 25 square inches of surface for each of the rectifier stacks. This can be reduced to as little as ten square inches in SSB application where the duty cycle is short. Both sides of the surface can be counted. I use a plate 40 square inches on a side. With it, the diode stacks seem to remain close to room ambient temperature. A commercial heat-sink could provide this surface in a smaller volume.

The plate was mounted vertically on a horizontal sheet of insulation that rests on the rectifier sockets. A two-inch bolt with its end threads filed slightly passed from the insulation down into one socket clip to connect to the idle filament transformer and the filter. Two stand-off insulators, with a small stack of washers on the bolt, made fine

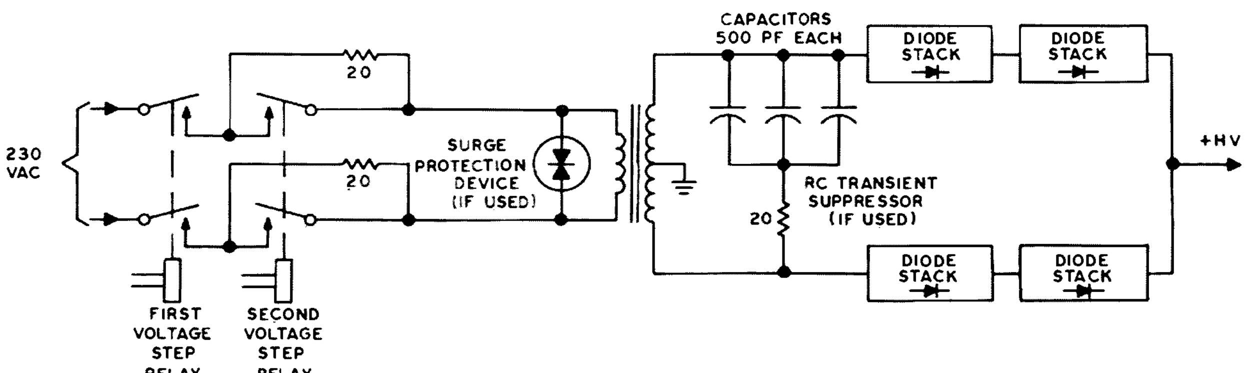

Fig. 1. Diode stack power supply.

places to attach the two plate clips from the ends of the transformer secondary. After carefully checking polarity, the four stacks of diodes, each the size of a package of chewing gum, were bolted to the aluminum plate.

In order to obtain quick start, the twenty-second amperite relay was removed from its socket, and a two-second one used in its place. No time delay at all is required, according to Bill Orr, W6SAI, at Eimac. However, I saw no reason to transmit before the filaments were fully on.

In a few minutes, the unit was plugged in and was on the air. The time from cold start to full power was four seconds, and much less after the thermal relays had warmed. It became possible to shut down the Henry 2K during round-table discussions and between calls, without waiting unduly to fire up the amplifier.

My Henry 2K was built in August, 1965, when Henry was using two-step power relays. In order to equalize the contact sparking, the series resistors had been doubled to 20 ohms each. This feature reduces substantially the tendency for a surge to damage the diode stacks. In the absence of the step-start feature, it would be desirable to use some surge protection, or to add one or two more diode stacks in each leg.

One protective measure was suggested by Frank Clement. This is to obtain three or four TV fly-back capacitors, which are 20,000 volt, 500 $\mu\mu$f, ceramic units. They cost about a dollar, but can be found in old RCA TV sets between the picture tube shield and ground, connected at the filament of the high-voltage rectifier tube. In series with these paralleled capacitors, place a 200-ohm resistor. This RC network is then connected across the entire power-transformer secondary – between the two standoff insulators on the heat-sink plate. It tends to absorb the voltage transient which is likely to occur about once each 150 times that the power relays open, and could exceed the diode stack voltage rating.

Alternatively, Jim Smith, W6RT, obtained a thyrector, General Electric No. 6rs21sal0dl0, found in the Allied and Newark industrial catalogs at a few dollars. The thyrector is connected directly across the power transformer primary. It may have to depend upon the coupling of the transient from the secondary to the primary, but has proved useful.

. . . K6KA

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Transistor Testing Techniques

The ham is, perhaps, gifted with an overabundance of ideas, and at the same time cursed by a lack of funds. To compensate for this continuing deficiency of the wallet, he tends to buy the many assortments of untested transistors, and, taking his trusty VOM in hand, proceeds to destroy what few or many useable transistors he found in the poly-bag. Instead of having a collection of good useable transistors, he has on his hands a collection of shorted three-leaded metal cans.

To prevent this needless loss, let us first review some basic facts about transistors. For lack of a better description we can consider a transistor as being composed of two back-to-back diodes (see Fig. 1). The base connection will always appear at the common connection of the two diodes. The orientation of these two diodes as shown in Fig. 1 will indicate whether the transistor is of the PNP or NPN variety.

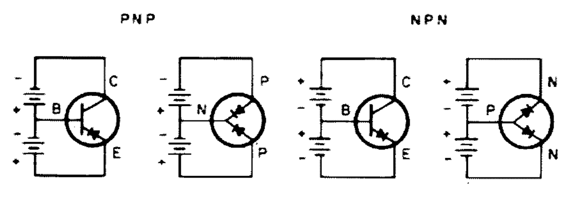

Fig. 2. Polarities for various tests.

As we can see from Fig. 1, there exists a difference of operating voltage polarity for each type.

In the case of the PNP transistor, the base is positive with respect to the collector, and negative with respect to the emitter. The NPN transistor is just the opposite, with the base negative with respect to the collector and positive with respect to the emitter. The collector-to-base diode junction is reversed biased and the emitter-to-base junction is forward biased in both the PNP and the NPN transistors. The collector and emitter are at opposite polarities in both cases.

The purpose of this brief review of what constitutes a transistor is necessary because in order to safely test a transistor, we must first understand the internal make-up and the differences which do exist in polarity. Many articles have described the use of a VOM for transistor tests. Unless care is taken and the polarity of each transistor element is carefully observed, the seemingly innocent testing procedure will result in the destruction of the transistor under test.

How, then, do you test a transistor safely but without buying a rather sophisticated and costly transistor checker? The answer lies in the *careful* use of your VOM. By making a few simple pre-tests and following the testing procedures outlines in this article, you will be able to test almost any transistor you might come across without damaging it.

The first step is to borrow an additional meter with a dc range of approximately 0-10 V. Switch your VOM to its resistance scale and measure both the voltage and polarity appearing at the test prods. Rotate the range switch until you find the least voltage (about 1.5 V) usually Rx10. Now comes the hard part; either misappropriate your mother's or wife's nail polish or be a coward and use paint. Mark this range with a small dot, and

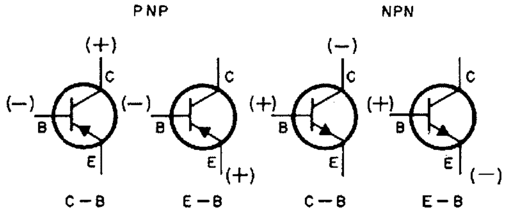

Fig. 1. We can consider a transistor as being composed of two back-to back diodes.

also indicate which prod is positive and which is negative. This may vary from VOM to VOM; many types reverse the polarity when in the resistance measurement ranges.

Testing procedures

It is most important to determine that each diode junction of the transistor under test exhibits low resistance in one direction and a high resistance in the other. Emitter to collector resistance should be high in *either* direction. Polarity is important at the emitter-base junction of small signal transistors due to the low reverse voltage rating of this junction. Only the forward resistance of the base-emitter junction should be measured. Emitter junctions of power transistors may be checked in both directions without fear of damaging the transistor. Fig. 2 shows the proper polarities for the various tests.

Reviewing what we have discovered and why we went to the trouble of measuring the voltage present at the test prods before we attempted to test a transistor, relates back to our earlier discussion of what a transistor is and how it is made. The value of approximately 1.5V is a safe range for making the forward reverse tests and will not damage a transistor. The exact meter reading is immaterial, what we are looking for is a definitive difference in the forward and reverse readings. In small signal (germanium) transistors forward resistance is in the neighborhood of 20 to 30 ohms. Small signal silicon transistors have diode junction resistances of from 40 to 60 ohms. In either case a reading of 15 ohms or less will indicate a short. Power transistors should exhibit a resistance (forward diode junction) of from 6 to 12 ohms.

To sum things up, we have discovered what a transistor is, how we can safely test it and what sort of readings we should expect. Please remember that small signal transistors should never be subjected to reverse resistance tests of the emitter-base junction. With proper techniques we now may safely test those bargain transistors; who knows, you might find the elusive 2N2219 you needed is really good.

...W9KXJ

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2 1/2 W Transmitter

As my hobby is transistors, I just had to keep building and of course – more power! This model checks out 2-1/2 w on Bird wattmeter. It has no dx record as yet except using a No. 47 bulb as a dummy load. Located on my work bench in the basement, making the transmitter about 2 to 2 1/2 feet below ground level, I worked a friend two miles away, getting an S6 report. Does anyone know how to make a good 5-element yagi using 47 dial lights?

This transmitter is held in reserve and will be my six-meter solid state job after the 1/4 w has done its job. I have the reputation of building up a job, using it for awhile and then tearing it down to use the parts in something else. Building is my hobby. If it works and the novelty has worn off, I'm ready to scrap it.

The coil forms for this unit were scrapped from some war surplus. They are ceramic 3/8" with iron slug and wound with 6 turns of about No. 20 silver plated copper wire. I used the coils as is and applied the necessary capacity to bring them to frequency, with the exception of adding links and tapping the final tank.

The 2-1/2 rig was built on a metal chassis as ground loops of current on a printed board could not be tamed.

The driver transistor was heat sinked with a slip over fin-type heat sink. The oscillator needed none. The final was a Bendix B3466 (looks like a TO-5 transistor pressed into a stud mounting case, with threaded stud at one end and wire leads from transistor at the other end). I used a 1/4" thick piece of brass, 1" by 1-1/2" on the stud as a heat sink.

I use transistor sockets on all my jobs so I can try out various transistors and change them easily when I blow them. (I cry a little too.)

With no shorts and power applied, the oscillator transistor is the one to worry about getting to work. The others are class C and will take "drive" to turn them on. All the oscillators mentioned are capable of lighting a No. 49 bulb, some brighter than others, depending on transistor and circuit.

The modulator used was an exact copy built up from the 5 w CB rig. described in RCA's transistor Handbook.

2N3553's or 40341 (both RCA) will work in the final. I intend to try a grounded collector and take the output from the emitter in another rig, so I can mount the stud (which is also connected to the collector) for better heat sinking. Maybe some of you have tried it.

The final may present a problem, due to the varactor action of overlay transistors. After tuning the final for maximum into a

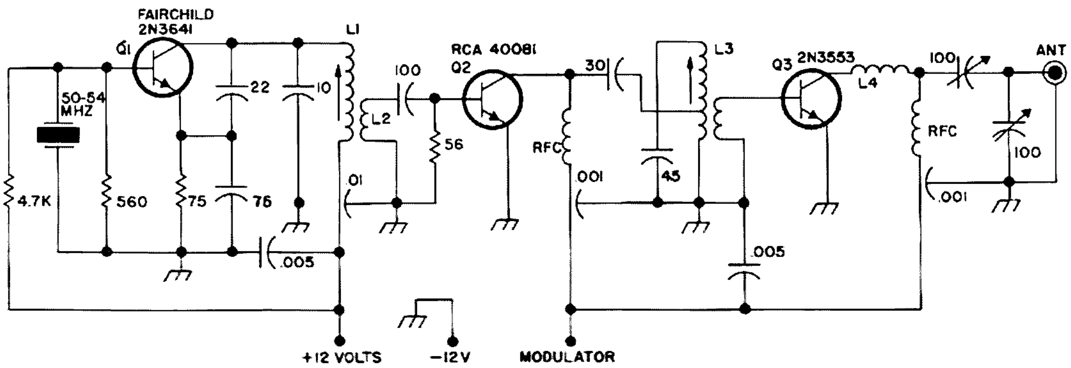

Fig. 1. Schematic of 2½ watt transmitter. L1 and L2 = 6 turns # 20 On iron core 3/8" ceramic form. Links are 2 turns # 20 insulated at bottom of L1 and L2. L3 is center tapped. These coils are 'war surplus' used 'as is'. Both windings are ½" long. L4 = 6 turns Airdux 516 or BW 3007. Q1 = Fairchild 2N3641; Q2 = RCA 40081; Q3 = Bendix B3466 or RCA 2N3553 or 40341 (all heat-sinked).

No. 47 dial bulb, and peaking the driver again, you may find a point where the power goes way down, and turning the slug in the driver stage will bring it back. I can get a little over three watts out on this rig, but it gets unstable to tune. Don't try for the utmost power output, but about 80 to 90%, which I have found to be where the driver and final are stable and will stay that way under modulation.

Ground the final emitter right at the socket by bending the emitter socket pin to the chassis and solder. Mount the driver coil on the opposite side of the between stage shield so the ground side of the final base link can come through the shield and ground at the same emitter ground, making this lead as short as possible.

You can try all sorts of transistors in these circuits. Even the 2N706's will work as an oscillator and driver (reduced power), but may "pop" under modulation in the 2½ W rig. Beware of some of the bargain transistor ads. A 2N697 may work at 50 mhz, but I haven't been able to get one to do so and if I did, it would be with reduced power and wouldn't be worth the effort.

...KØVQY

Soldering to Desolder

Of course, we all know how to make good soldered joints. First, one makes a tight mechanical joint by wrapping the wire around the terminal, firmly. Then one applies the solder, by first heating both the wire and the terminal hot enough to melt the solder and then applying the rosin-core solder to the parts to be joined.

However, in experimental work, it frequently becomes necessary to unsolder the joints thus made. This entails removing the solder and unwrapping the wire. Not only is this a difficult job—it is often destructive to the components. A simple expedient in such work is to avoid making a tight mechanical joint by bending a short loop on the end of the wire and hooking this to the terminal to which it is to be connected. Applying a drop of hot solder completes the job. Later, in changing the circuit, one needs only apply the hot soldering gun and the hook will slip off very easily.

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Neutralizing the HX-10

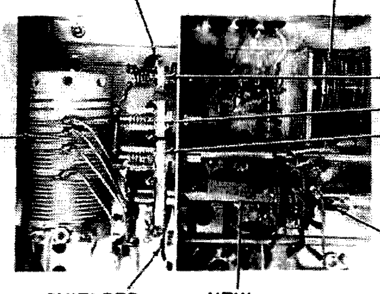
A few HX-10 owners have experienced a neutralization problem with this sturdy SSB transmitter on 10 and 15 meters. Per the instruction manual, neutralization is accomplished at a frequency of 14250 khz and generally holds well enough for satisfactory all-band operation. However, due to the nature of the neutralization circuit employed in the HX-10, some degradation in neutralization occurs at frequencies removed from 14250 khz with resultant occasional instability on 15 or 10 meters. Neutralizing the rig on 15 or 10 meters produces little improvement as instability can then occur on the lower bands. The 20 meter "compromise" neutralization, while effective on 80, 40, & 20 meters, leaves something to be desired on 10 and 15 meters.

As a result of this problem, the following symptoms have been experienced in tuning some HX-10 transmitters on 15 and 10 meters. Plate and grid control adjustments are very touchy and interact with each other. At times the 6146's take off on their own. This is evidenced by a full power forward indication on the SWR bridge with no audio input. Slight movement of either the grid or plate control usually stops this oscillation. On the air reports on 15 and 10 are not always satisfactory; the signal is often broad with fuzzy audio quality, sometimes accompanied by spurious radiation on either side of the fundamental signal.

In solving this problem with my own HX-10, and after much consideration, it was decided to install two additional neutralizing capacitors; one for 15 meters and one for 10 meters. These would function independently of the original one, which would be retained for the 20, 40 and 80 meter bands.

The following step-by-step procedure is provided for those who wish to perform the same modification:

1. Remove tank coil L12 from present location by carefully unsoldering all leads,



Modified HX-10.

and removing screws in stand-off insulators.

2. Place band-switch in 3.5 mhz position.

3. Unsolder all remaining leads on band-switch wafer BS7 and remove it from the end of the switch shaft.

4. At the open space adjacent to capacitor C45 (in the 6146 compartment), carefully cut the shaft of the band-switch approximately 3/8" from the dividing partition (refer to picture) with a hacksaw. This is in preparation for adding a longer shaft section with a coupling. Place a rag under the shaft to catch metal chips.

5. Slide the cut shaft section toward the rear chassis apron until it touches the apron. Locate this position on the other side and drill a 5/16" hole through the apron. This hole will permit installation of the new, longer shaft section. Remove the short section of shaft and discard. Be careful not to move the position of the wafer switch rotors.

6. Obtain a new shaft section 3-3/4" long with the same diameter and flats as the original. Also procure a single pole 11 position wafer switch section which is required for switching the three neutralizing capacitors. Only seven positions of the switch will be used. (See Fig. 1.)

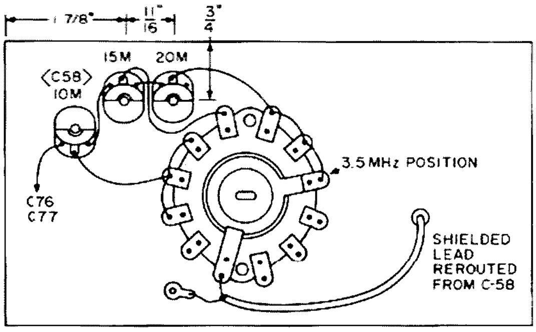


Fig. 1. Rear view of neutralizing switch.

7. Slide the new switch shaft through the hole in the rear apron and through the centers of the switch sections in the adjacent 6146 compartment. Be careful not to disturb their position. Connect the new shaft section to the old one using a conventional ¼" coupling. (Refer to photo.)

8. Wire the new 11 position wafer switch section with jumpers and 3 inch lead extensions as shown in **Fig. 1**. Position the rotor or armature of this switch in the 3.5 mhz position as shown in the figure.

9. Using 1/8" and 3/8" spacers, and longer screws, mount the two switch sections on the end of the new shaft. Be sure the tank switch section is in the 3.5 mhz position and installed as removed. (Refer to **Fig. 2**.)

10. Locate C58, the original neutralizing capacitor, and the shielded lead connected to the lug under the knob. Unsolder this shielded lead from C58 and the ground lug and reroute it through the hole vacated by the tank coil stand off insulator screw. Keep this lead close to the chassis and connect it to the armature lug of the new wafer switch section. Refer to the photo and **Fig. 1**. Connect shield to nearest ground lug.

11. In accordance with dimensions in **Fig. 1**, locate and drill holes for mounting the two new neutralizing capacitors. Holes must be of correct size to allow proper seating of shoulders on insulating washers used to isolate each capacitor shaft from ground. The location of original neutralizing capacitor remains unchanged.

12. Mount new 0-9 pf capacitors (Hammarlund MAC-10 or the equivalent) in these two holes as shown in the photo. Be sure to use insulating washers on threaded bushings.

13. Connect the three wires extending from the new switch section to the *rotor*

terminal of their corresponding neutralizing capacitors as shown in Fig. 1.

14. Connect the stators of all three neutralizing capacitors together with jumper wire.

15. Reconnect all leads and capacitors removed from band-switch section BS7 to original connections (except tank coil connections).

16. Remove chassis ground terminal from rear apron to make clearance for new tank coil location. Drill hole and relocate ground screw approximately one inch toward accessory socket.

17. Refer to Fig. 2 and drill the two holes required to relocate the tank coil in its new position.

18. Carefully remove the two stand-off insulators from the tank coil and remount them on the opposite side of the coil. This permits the coil to be mounted as shown in the picture with the tap loops toward you.

19. Mount the tank coil as pictured.

20. Using new wire, reconnect the tank coil to the band-switch section BS7, and to other connection points. Keep all leads as short as possible to minimize the effect of additional inductance on the high frequency bands. Check solder connections to taps on tank coil to insure that solder is not touching adjacent windings.

21. Check all connections to BS7 and L12 to make sure they are connected to the original tie points. Remove all drill chips.

22. Install knobs on shafts of new neutralizing capacitors.

23. Following Heath manual instructions, neutralize the HX-10 on 14250 khz using the original C58 capacitor.

24. Next neutralize on 21250 khz using the new 15 meter neutralizing capacitor.

25. Then neutralize on 28500 khz using

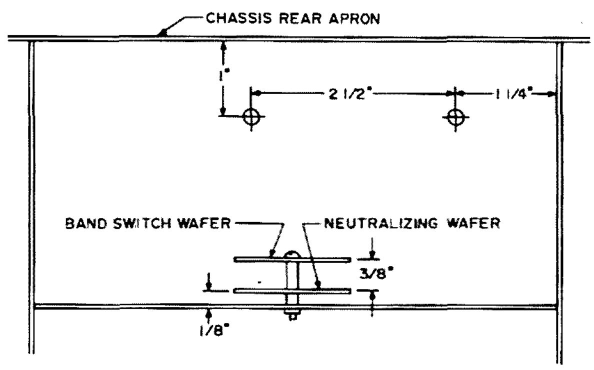


Fig. 2. Position of switch decks.

the new 10 meter neutralizing capacitor.

26. After completing neutralization for all three bands, repeat the process, as there may be some interaction between these adjustments due to the close proximity of the 3 capacitors.

If it is found that the tank tuning capacitor C77 is at minimum capacitance when resonating on 10 or 15 meters, it may be necessary to remove one or more plates from this capacitor to further reduce the effective capacity. This may be required due to the relocation of the tank coil and the slight increase in lead lengths involved. I removed three plates in order to bring the front panel markings back to the original band locations. Plates are removed by using needle nose pliers and carefully bending the plate loose at its soldered connection points.

This modification has worked well for me and has eliminated the neutralizing trouble which prevented satisfactory operation of my Marauder on 10 and 15 meters.

. . . W2PQG

Low Cost Capacitor Covers

More often than not the high voltage supply for a modern transceiver or linear uses several capacitors in series, all capacitor cans, except the one at the cold end, above ground. This is an inexpensive way of eliminating bulky high voltage capacitors. Homebrew design has followed suit to a large extent.

There is a distinct disadvantage to having the capacitor cans above ground. The cans are hot electrically and present a serious safety hazard if not covered in some manner. Having built a 3000 volt power supply and not desiring to build a metal cage, catalogs were consulted in hopes of finding an inexpensive Kraftpaper tube of the type so often seen in TVs. No luck, not only were they expensive, but they didn't come in the required length.

Why not cut lengths of cardboard tube from that most noble of paper products? Because it's too large, that's why. But there are ways around that, and besides we need protection on the top of the can anyway. How about painting the tube flat black to obscure its ancestry, slipping it over the capacitor and sealing it in place and covering the top with silicone rubber (black if possible). It works fine and costs almost nothing.

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More Taylor Modulation

In the past few years there has been a large interest in the Taylor modulation system, as well as other high efficiency types of modulation. When the first article was written, I became interested in this system. As a result of this interest I did some research and letter writing and would like to pass on the information I have gained.

To begin with, R. E. Taylor made a fascinating discovery and introduced his form of Super-modulation in 1942, when he was issued U. S. Patent number 2,282,347. According to Taylor, up to 87 percent efficiency is possible through this form of operation.

The system consists of two tubes, one tube operating as a power or *rf* amplifier and the other tube operating as an audio amplifier. The principle of the system is to connect the two tubes together in such a way that one tube may be adjusted to handle the *rf* carrier and the negative modulation peaks with maximum efficiency, and to adjust the other tube to carry the positive modulation peaks. Two examples of this system are the Doherty linear amplifier and the Terman-Woodyard high-efficiency grid-plate modulation system. However, both of these systems employ quarter-wave impedance-inverting lines, which are very

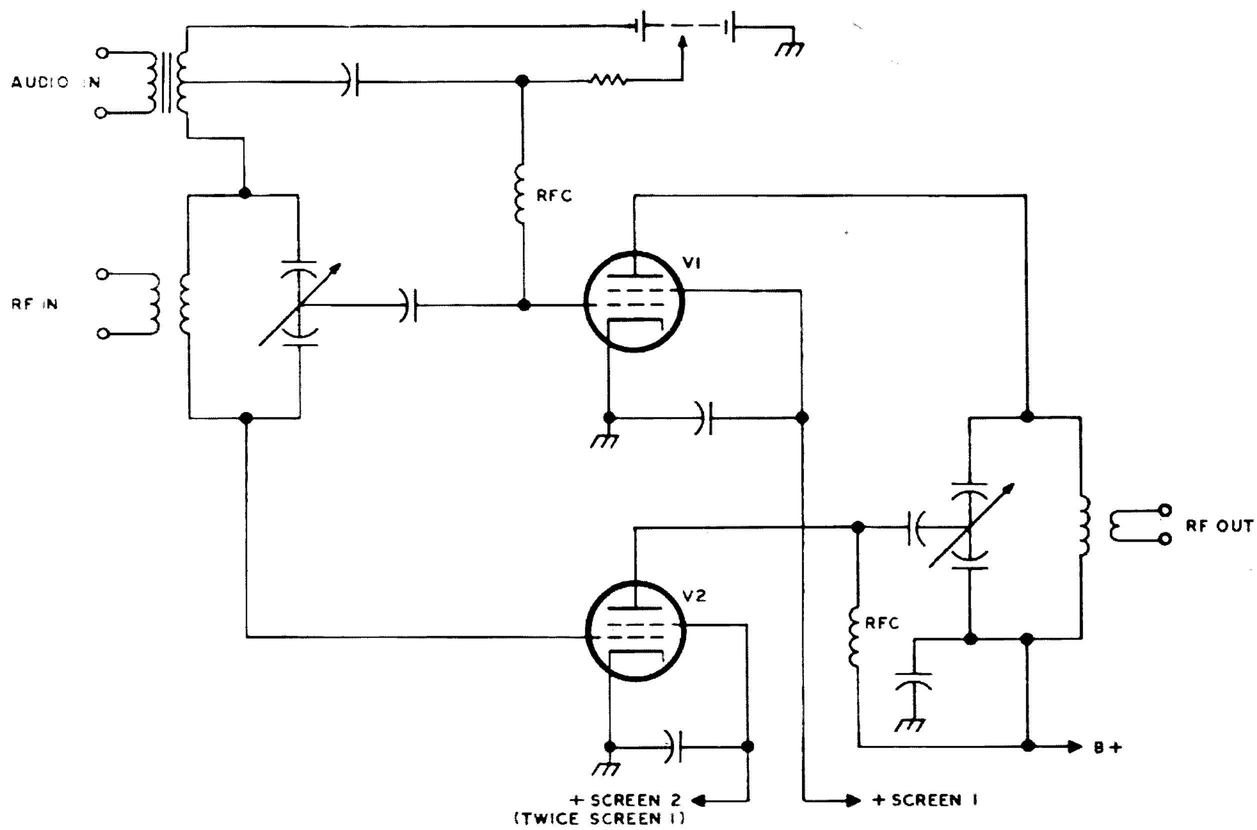

Fig. 1. A basic super-modulation circuit with two grid modulated amplifiers connected to a common tank circuit.

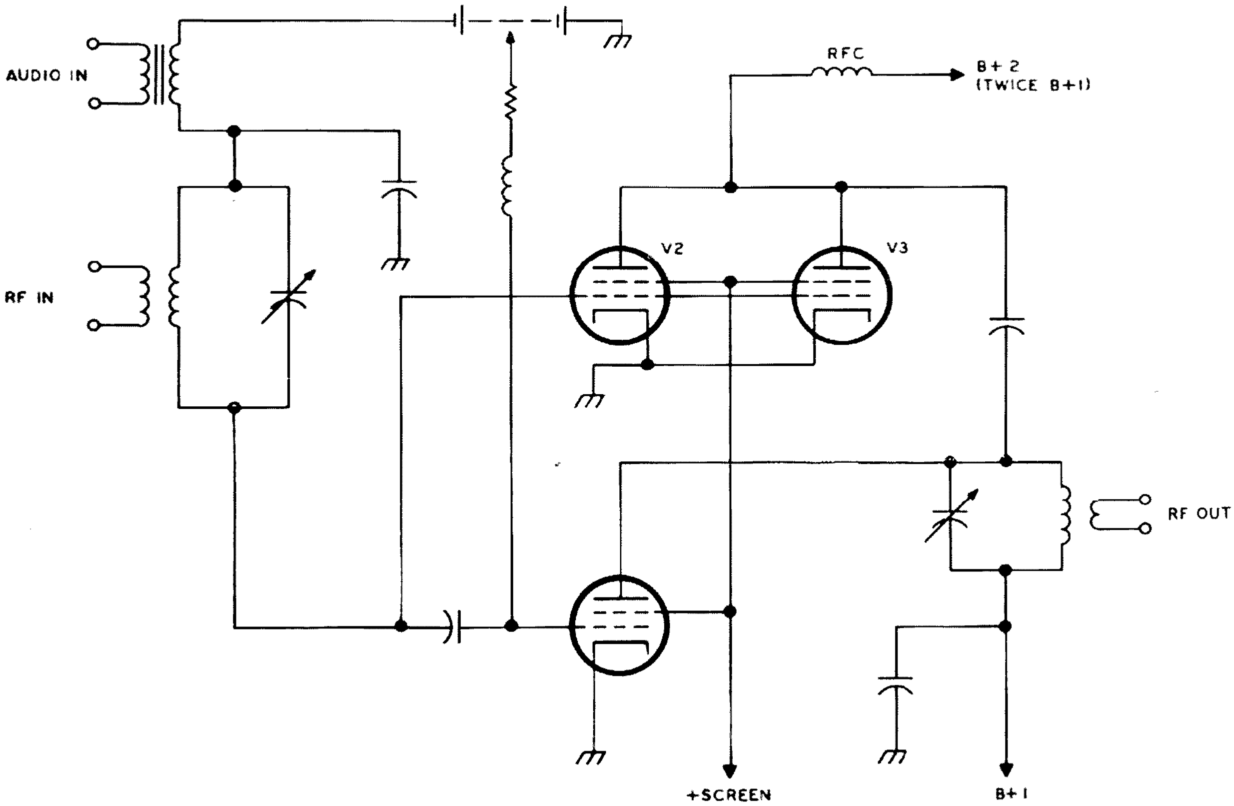

Fig. 2. A variation of the circuit in Fig. 1 in which a dual voltage power supply is used.

difficult to adjust and almost impossible for the average amateur.

Taylor, however, has shown that the quarter-wave lines may be avoided, and still maintain an efficiency nearly equal to the previous two examples. In his system, the dc input to the peak tube (audio amplifier) increases while the input to the carrier tube (*rf* amplifier) decreases.

Basically then, the super-modulation circuit is composed of two grid-modulated amplifiers which are connected to a common tank circuit. In **Fig. 1**, a basic system is illustrated. As shown, the peak tube (V2) is biased beyond cut-off, and therefore contributes no output. The carrier tube (V1) is operated in a nearly saturated condition, and therefore, delivers its maximum output. Due to the low plate dissipation in this system, the efficiency will be good. As can be noticed in **Fig. 1**, the peak tube (V2) is delivering it's *rf* output to a tap at the center of the tank circuit, and must therefore deliver four times the carrier tube's carrier level in order to effect full upward modulation. This is because, first, the carrier tube (V1) delivers no output; and second, the peak tube (V2) is connected to a load impedance of only one-fourth the impedance presented to the carrier tube.

One way to do this is to operate the carrier tube at a lower screen voltage than the peak tube. Then, by using a rule-of-thumb measure, if the peak tube is given a screen voltage of 2.5 times the screen voltage applied to the carrier tube, it should be just able to handle the peak. Of course, as the screen voltage on the peak tube is raised, the requirements for higher bias, modulating voltage, and *rf* driving voltage will also increase.

A variation of the circuit of **Fig. 1** is shown in **Fig. 2** where a dual voltage power supply is required. In this case, the peak tubes are shunt fed, and supplied with two times the voltage applied to the carrier tube, which therefore prevents saturation until it reaches twice the carrier level. As can be seen in **Fig. 2**, there is no center-tap in the output circuit, and therefore the current in the tank circuit need be doubled only at modulation peaks.

The two tubes will supply this current sufficiently with the same screen voltage, modulation voltage, and *rf* drive. The only difference is in the dc bias levels.

There are many variations of this type of modulation, most of which have appeared in print in earlier publications. Therefore, I will not go into the many variations on Taylor Modulation. I am listing my references, for anyone interested in additional information. I would highly recommend the article written up in *73 Magazine* by Fred Dougherty, W3PHL, for additonal basic information.

To those not interested in this form of modulation I wish to say, if you haven't tried it, don't knock it.

. . . DL5KS

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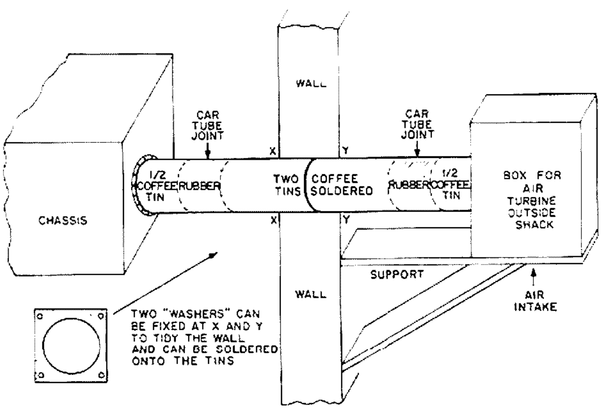
A Large Volume of Silent Air for a Large Tube

Here in East Africa it is quite impossible to buy ham shack requirements.

I have no doubt that it is possible to buy quiet blowers to fit into a chassis, but it is two months to wait over here. In any case, the average ham loves making gadgets and is always trying to improve apparatus and gild the lily.

I like a quiet shack, and a noisy blower is a pest. I found a real large size blower which cost two dollars, complete with its squirrel cage; nobody wanted it as it was 110 volts and we use 240 volts. As simple as that. But what a noise and volume, ¼ HP motor and all. After promising to make good if necessary, I chipped out a 3½" hole through the shack wall near my P.A. (use a small pilot hole to check your measurements) and collected some 3½" diameter coffee tins, cut the bottoms out, soldered two together and stuck them in the hole. With rubber inner tube you can make fine couplings at any angle by trial and error using the curve of the tube. The chassis has half a tin soldered on the side for the intake. With such a powerful blast of air (noiseless) you can afford to ignore sealing the chassis and don't even need a bottom plate if your bench is flat.

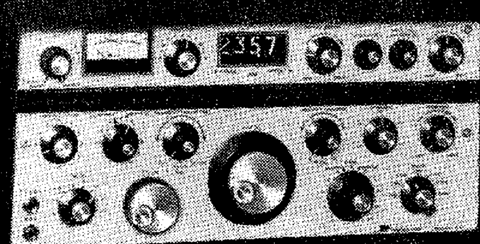


You have guessed it - it's a 3-1000Z Eimac tube which is loaned by a friend, and I dare not risk overheating it. It's a tube worth taking trouble over and a good supply of air is the least you can do for it. The air blower was mounted on brackets on the wall outside and coupled up with more inner tubing and a weather-proof roof tied on.

E. Robson, 5Z4ERR

Edit. Note

Many of these new tubes require a blower, a good one; even if only the filaments are on.



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An Audio Sinusoid Generator

Do you need an audio generator which delivers a sine wave over the frequency range of 500 hz to 5 khz? The oscillator described here will do the job while maintaining a nearly constant output voltage over the range of 1 khz to 5 khz.

An audio oscillator which generates a low-harmonic-content sinusoid has many uses. Examples include two-tone generators for use in amplifier linearity tests and AFSK oscillators for encoding Teletype signals for radio transmission. The oscillator described here is well suited for the latter application because switching different capacitors into the circuit allows generating two equal-amplitude non-simultaneous tones using the same oscillator.

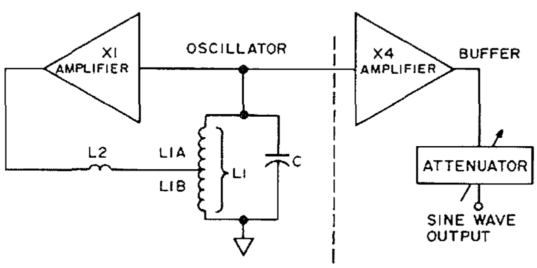

Fig. 1. Sine wave oscillator and buffer.

Fig. 1 illustrates the complementary audio oscillator circuit. The npn-pnp amplifier has a unity voltage gain and is active over a 10 volt dynamic range. The complementary amplifier provides drive through L2 to the tuned circuit composed of L1 and C. The single-ended buffer amplifier prevents heavily loading the tuned circuit. The circuit uses two 88 mh telephone loading coils. These toroid inductors have two windings which can be connected in series for L1 = 88 mh or only one of the windings can be used for L2 = 22 mh.

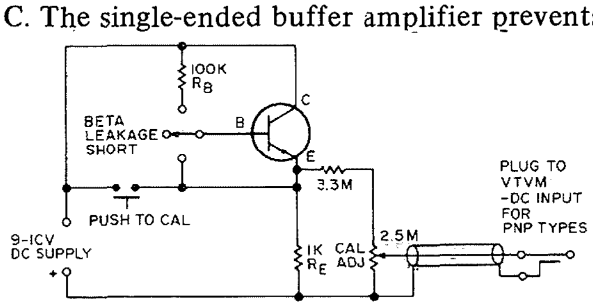

Fig. 2. Functional diagram of oscillator and buffer.

The operation of the oscillator is better understood by considering the functional diagram illustrated by **Fig. 2**. The current which flows through L2 is in phase with the voltage developed across the tuned circuit. The output voltage from the X1 complementary amplifier is divided between L2 and L1B. The drive voltage to L1B does not vary with frequency between 1 khz and 5 khz.

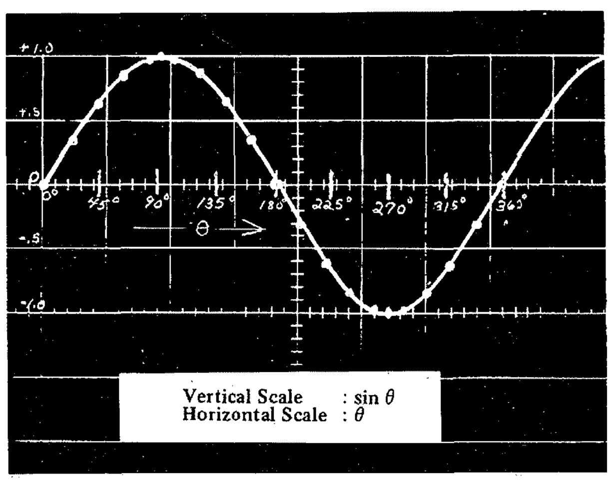

Fig. 3. Plotted points of sin θ superimposed upon measured output waveform.

Consequently, the output voltage is constant over this frequency range. The buffer amplifier has a voltage gain of 0.4 and drives a potentiometer which can be adjusted to provide a sine wave output of zero to 9 volts peak-to-peak.

Fig. 3 shows an oscilloscope photograph recorded to show the quality of the sine wave as measured at the output of the buffer amplifier. Points are plotted on the oscillograph to show the theoretical waveform of a pure sinusoid. The oscillograph in **Fig. 4**

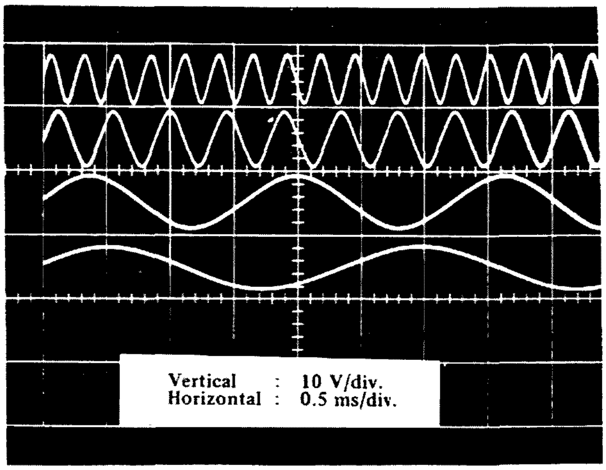

Fig. 4. Measured output waveforms.

shows the waveform quality at four operating frequencies in the range of 400 hz to 4 khz. The waveform distortion decreases with frequency. The results of distortion analyzer measurements made on the signal output from the buffer show a waveform distortion of 4% at 3.5 khz and a 1.4% waveform distortion at 500 hz. Filters can be used to decrease the waveform distortion to less than 0.1% if required.

The output voltage is plotted as a function of frequency in **Fig. 5**. The decrease in output voltage at lower frequencies is caused by: (a) The Q of the resonant circuit decreases at lower frequencies; (b) the inductive reactances of L2 and L1B decrease at lower frequencies, and the voltage drops across the 100 emitter resistors become appreciable. The oscillator can be made to operate at lower frequencies by increasing the values of L1 and L2.

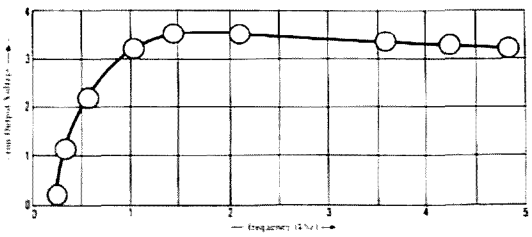

Fig. 5. Measured output voltage from buffer.

Fig. 6 shows a graph which can be used to select a value of C for any desired oscillator frequency. The error bars above and below the plotted data points reflect the ± 20% tolerance of the capacitors used to obtain the data.

The choice of semiconductors is not critical except that silicon transistors and silicon diodes should be used. The bias conditions are designed to make use of the forward voltage drop (0.7 volt) across a silicon diode. The power supply voltage values are not critical. If the semiconductor breakdown voltage specifications are not exceeded, higher output voltage can be obtained by using higher power supply voltages. The physical layout of the components is not critical, and special construction techniques are not required.

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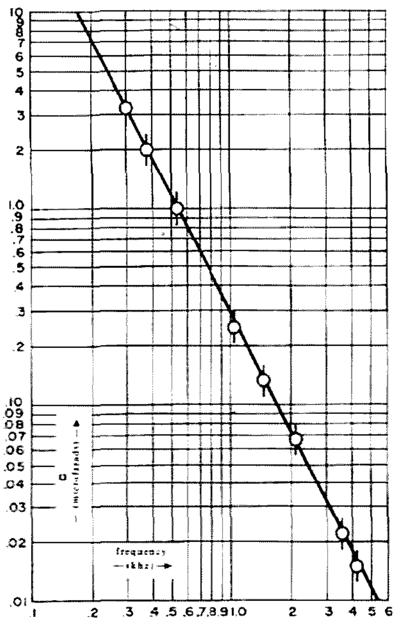

Fig. 6. Capacitance vs oscillator frequency.

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Capacitor Usage and Electron Flow

How long has it been since you looked at a schematic in one of *73*'s construction articles and said to yourself, "Hmmm... wonder what *that* capacitor is there for?" Chances are that unless you are an engineer, there will be at least one capacitor in this very issue that will mystify you. This article is designed to dispel the mystery by describing the electron flow and pointing out examples of common capacitor usage.

Note that the word "capacitor" has been used consistently in lieu of "condenser". "Capacitor" is the word specified by someone at IEEE, and there seems little reason to quibble with them. It does seem a little more logical, tho some old timers still had rather fight than switch.

Texts and handbooks devote several pages to the theoretical aspects of isolated capacitors, but most do not say much about their functioning in practical circuits. Knowledge of dielectric constants, formulas, plate spacing, and fabrication techniques is worth having. However, it is more useful to a design engineer than a ham or technician. The reader interested in the more theoretical approach is referred to suitable handbooks.

Knowledge of the specific function a particular capacitor performs in a given circuit is a valuable troubleshooting tool when it comes to locating a malfunction in either homebrew or commercial gear.

What a Capacitor Is

A capacitor is an electrostatic device. Its purpose is to store electrical energy in the form of a static electric field. Remember that "static" means "standing still" or "unmoving". This is in contrast to an inductor which stores energy in a magnetic field only so long as the electrons are moving thru a coil.

The electrostatic field is created when electrons are pulled from one plate of a capacitor by an applied voltage and an excess is forced into the other plate. Since unlike charges attract each other, it is as if the plate with a deficiency of electrons is trying to pull some from the plate which has an excess. It does succeed in pulling them to the surface of the other plate, but can not pull them thru the insulation of the dielectric which separates the plates. However, when there is a direct connection between the plates in the external circuit, the charges will flow together and neutralize each other.

It is not possible to understand how a capacitor operates in a circuit until the charge and discharge paths can be traced. These two paths are not always the same. It is at this point that understanding of most hams is inadequate.

Coupling Capacitor

Terms used to describe this component have done more to confuse beginners than to enlighten them. At least one writer of elementary texts has been observed to call it a "coupling condenser" and a "blocking capacitor" all in the same paragraph. For those interested in the whole boring story, the correct designation would be: an ac coupling-dc blocking capacitor. Obviously this is an inconveniently long name, so it may get shortened to coupling or blocking capacitor. Which it is called depends mostly on the writer's whim.

The coupling capacitor is always in a signal path, for the signal is what it was put there to couple from one circuit to the oth-

er. It is most frequently used in resistance-capacitance coupled amplifiers similar to those in Fig. 1. The purpose of the capacitor C, is to transfer the signal from the plate circuit of V1 to the grid circuit of V2 while preventing the high level dc voltage from following the same path. It has a continuous dc voltage across it during the time power is applied to the circuit. The signal voltage causes momentary increases and decreases in the average charge as it swings more or less positive at the plate of V1.

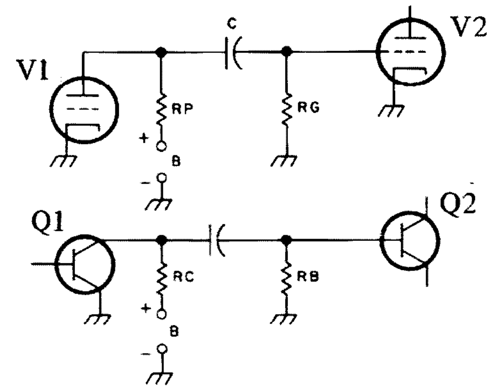

Fig. 1. Resistance Coupled amplifiers;
(A) Tube type, (B) Transistor type

The charge path for C in Fig. 1A during a more positive signal voltage swing at the plate of V1 is such that electrons will move up from ground, thru the tube cathod to the plate and into the left plate of the capacitor. They will flow out of the right plate, thru Rg and on to ground. The negative voltage at the top of Rg will therefore increase in step with the signal at the plate.

Discharge occurs when the voltage at the plate of VI swings less positive. Electrons will flow out of the left plate of the capacitor, down thru Rp, thru the B supply to ground and up thru Rg into the right plate. This makes the right plate of the capacitor, and hence the grid of V2, less negative with respect to ground. The grid may still be negative with respect to the cathod if suitable biasing is provided. Thus the signal applied to the grid is developed across Rg.

Electron flow in the transistor circuit of Fig. 1B is essentially the same as in the tube circuit.

It can be noted from the foregoing explanation that there is a phase shift as the signal "passes thru the capacitor." This is not as great as would at first appear because the time constant of the capacitor and resistors in the charge and discharge paths limit the shift. It is this phase shifting which

makes possible operation of the phase shift oscillator illustrated in Fig. 2. In practice, it works out that there is usually somewhat less than ninety degrees of shift. That is the reason three capacitors are required to sustain oscillation in the circuit of Fig. 2.

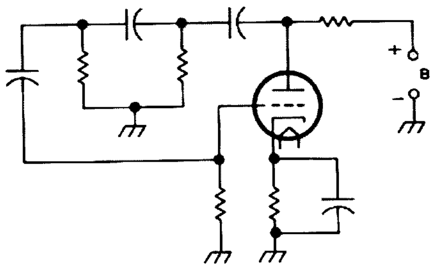

Fig. 2. Phase-shift oscillator.

The coupling capacitor becomes a "grid leak" when *rf* is supplied from V1 and no bias is placed on V2. If the value of C and Rg are properly chosen, C will have time to discharge only slightly between *rf* peaks. Then the voltage at the grid of V2 will have the general waveform of the AM modulation on the *rf* input voltage.

Capacitors function in a similar manner in many tone control and pulse shaping circuits. Such circuits are becoming more important to hams with the increasing use of integrated circuits and digital techniques. As stated earlier, a capacitor with the purpose of coupling a signal must be in a signal path.

All types of capacitors are used for coupling with the possible exception of high voltage and variable types. Small film types are used in *rf* circuits. The range runs all the way to large electrolytics in low impedance audio frequency circuits. The type chosen for use depends on applications and mechanical considerations.

Bypass Capacitor

The bypass capacitor is known by even more names than is the coupling capacitor. Depending on just where it is located in the circuit, it is variously called a smoothing capacitor, filter capacitor, feed-thru capacitor, integrating capacitor, decoupling capacitor, or of course, a bypass capacitor. Attempt will be made to show that these functions are all essentially the same.

Let's start with the common filter capacitor, sometimes called a smoothing capacitor. Fig. 3 shows the common configuration of a power supply filter. The purpose of both the capacitors is to bypass the ac ripple remaining in the rectifier output before it reaches the load. Electrolytics or oil filled capacitors are most frequently used in this application.

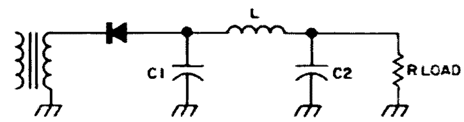

Fig. 3. Power supply with filter.

The charging path for C1 starts at the negative plate from which electrons are pulled when voltage is applied. They continue to ground, up thru the transformer secondary, thru the diode, and finally into the positive plate. The path for C2 is identical except that inductor L is included in it. In many circuits, especially low current supplies, the inductor is replaced with a resistor. The electrons are moved around the circuit by the voltage induced in the secondary of the transformer.

During discharge of C1, electrons flow out of the positive plate when the applied voltage is momentarily decreasing, and go on thru the choke since they cannot go back thru the diode. They proceed thru the load represented by R, on to ground and into the negative plate. In this case the path for C2 does not include the inductor, tho it is otherwise the same as for C1.

The electrons flow during discharge because the voltage being applied to the capacitor is insufficient to maintain the electrostatic field which holds the electrons in the capacitor positive plate. The capacitors of the filter thus supply current to the load during the intervals when the rectifier is not doing so. The energy stored in them during the charging part of the cycle is returned to the circuit during discharge.

It should not be inferred that discharge is complete while the filter is operating. The very purpose of the arrangement is to prevent variations, so far as possible, in the current. Large values of capacitance are chosen to accomplish this.

Decoupling capacitors operate in the same way as the filter capacitors just described. The only reason for the difference in name is the part of the circuit in which they are used.

Fig. 4 shows an AVC decoupling network. Its purpose is to shunt to ground any audio or *rf* that might get into the AVC line whether it comes from the rectifier or one of the branch lines. No appreciable current flows in the line for tube circuits, since the tube grids in which it is terminated are negative with respect to

ground. Current does flow in transistor AVC lines in most cases since they are current controlled devices. This will somewhat modify the discharge path for the capacitors. The current consuming transistor can be thought of as equalivent to the load in Fig. 3.

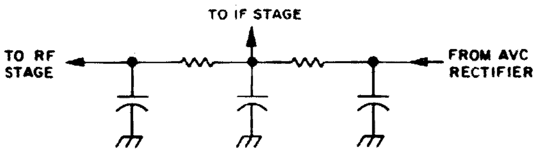

Fig. 4. Decoupling filter, AVC type.

Since the electron flow paths are so similar to those of the previous figure, it will be left as an exercise for the reader to trace them.

Decoupling capacitors are also used in dc supply lines to keep signals which are generated in the stage which the line supplies from getting into other stages by way of the line. The circuit looks almost exactly like that of Fig. 4 when the labels are changed.

Feedthru capacitors are used to bypass to ground *rf* which may have been picked up by supply voltage lines as they enter or leave a compartment where stray signals may be present and induced into the supply lead. These are seldom larger than a few tens of picofarads. They may be small ceramic types or a cylinder of metal with an insulated lead for the supply voltage running thru its center. Heater bypass capacitors are very similar.

Feedthru and heater bypass capacitors are simply special cases of decoupling capacitors. Tracing their charge and discharge paths is not difficult if it is kept in mind that the source of supply is voltage induced into the leads which they bypass. Once this is borne in mind, the paths are found to be very similar to those of Fig. 3.

Fig. 5 shows a circuit containing both a cathod bypass, Cc, and a screen bypass, Cs. The purpose of both is to keep the signal

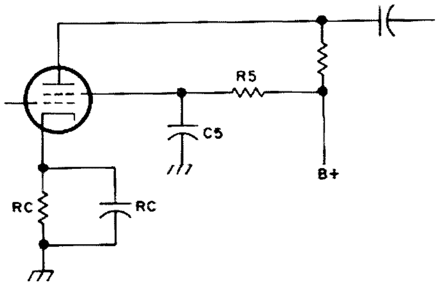

Fig. 5. Tetrode amplifier showing bypass capacitors.

voltage off the respective elements. They operate in slightly different manners.

When VI conducts, the top of the cathod resistor, Rc, becomes more positive with respect to ground. Some of the electrons coming up thru the resistor leave the stream and flow into the positive plate of the capacitor. At the same time some flow out of the negative plate and up thru the resistor.

When there is a decrease in the positive voltage on the top of Rc, some electrons flow out of the positive plate and join those coming up thru the resistor and go on thru the tube, the load, power supply, on to ground and back into the negative plate of Cc. In this way voltage variations tend to be leveled out.

Value and types for Cc depend on the operating frequency. Electrolytics of several mfd are used in audio circuits. Tubular and disc types are used in *rf* circuits. Values for *rf* work are usually from .001 to .01 mfd in both transistor and tube circuits.

Charge of the screen bypass, Cs, begins when power is applied to the circuit and the top of the screen resistor becomes positive with respect to ground. Electrons flow from the grounded negative plate, thru ground, Rc, the tube as far as the screen and into the positive side of the capacitor.

During a momentary decrease in the positive voltage at the screen caused by signal voltage getting into the screen circuit, electrons flow out of the positive plate, thru Rs to the power supply, on to ground and into the negative plate of Cs. Ac voltages of almost any frequency appearing at the screen are neutralized by the charging and discharging of Cs which tends to maintain a constant voltage at its junction with the screen and Rs.

Values for Cs are usually less than .01 mfd for audio and are only a few hundred pf for *rf*. Ceramic and paper types are widely used.

Resonant Circuit Capacitors

Resonant circuit capacitors are the easiest of all to recognize on a schematic because they are always associated with an inductor. In addition, they are variable types in a high percentage of cases. An understanding of electron flow in them aids in understanding other facets of operation of the resonant circuit.

Referring to **Fig. 6**, the symbol for the ac generator can be replaced by tubes, transistors, or antenna-ground systems responding to electromagnetic radiation, etc. In the explanation it is assumed that the circuit is being excited at its resonant frequency.

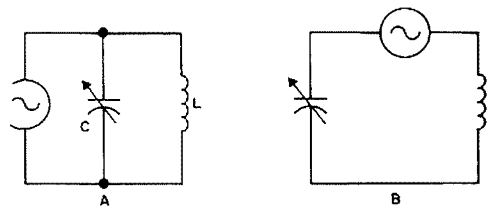

Fig. 6. (A) Parallel resonant circuit; (B) Series resonant circuit.

When the upper terminal of the generator in **Fig. 6A** becomes negative with respect to the lower one, electrons will flow from the negative terminal into the upper end of the coil. The upper plate of the capacitor will also contribute some electrons to the stream. After going thru the coil, some electrons will continue back to the generator and some will go into the lower positive plate of the capacitor. It is now plain that more current is flowing in the coil than in the wiring outside the resonant circuit.

At the instant when the applied voltage reaches its peak, the maximum amount of energy is stored in the circuit. Electrostatic energy is in the capacitor and electromagnetic energy is stored in the field surrounding the coil.

As the applied voltage decreases the stored energy is returned to the circuit. The magnetic field around the coil collapses. This induces a counter voltage in the coil that tends to keep the current flowing in the same direction with as little change in rate of flow as the component values will permit. The capacitor supplies the current for this process, since by this time the generator voltage is dropping to a low level. In doing so, its charge at the peak has become completely reversed. Continuing the cycle, the voltage across the generator becomes reversed. Current in the external circuit is also flowing in the opposite direction that it was during initial charge. Some of the stored energy is dissipated in circuit resistance contained mostly in the wire of the coil. The generator furnishes small amounts of energy to replace that lost in the circuit. It also replaces energy coupled out of the circuit by such means as a nearby coil in which a voltage is induced.

Electron flow in the series resonant circuit of **Fig. 6B** is very similar to that of the parallel circuit discussed above. As shown in the figure, it can be visualized as a parallel circuit with the generator inserted in series

with the components. Therefore the high current circulating in the resonant circuit will also flow thru the generator.

Parallel resonant circuits are used to present a high impedance to *rf* currents. The higher the impedance, the higher will be the voltage developed at the frequency to which it is tuned. This is desirable whenever it is neccssary to pick out a small group of frequencies from among many possibilities. A few typical uses are in antenna circuits, tuned amplifiers, and oscillator frequency control circuits.

Series tuned circuits offer a low impedance path for a particular small group of frequencies to which it is resonant. The best known use of this function is for bypassing a specific unwanted frequency to ground from the antenna input. It is sometimes used in selective coupling circuits and as a feedback path for oscillators.

Combinations of the two types of circuits are used to produce many characteristics in band pass, band rejection, high pass, and low pass filters.

Timing Capacitors

The fourth use is as timing capacitor. It is not often used in ham gear, but does appear in oscilliscope sweep generators and pulse generators. Such circuits are becoming more common as digital techniques are applied to communications.

Fig. 7 shows the basic circuit. It is frequently called a relaxation oscillator. The voltage waveform across the capacitor will have a slow rise-fast fall sawtooth shape. The charge path for the electrons is out of the lower plate of the capacitor, thru the B power supply, down thru the resistor and into the positive plate.

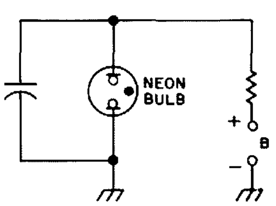

Fig. 7. Neon bulb relaxation oscillator.

Partial discharge occurs when the voltage across the capacitor reaches the firing potential of the neon bulb. This voltage varies from 60 volts up. At firing, electrons flow out of the positive plate, thru the neon bulb, and into the negative plate. When the capacitor discharges to the point that the applied voltage will no longer keep the gas ionized, the bulb is extinguished and conduction stops, and charging begins again. The extinguishing voltage is only a few volts below that for firing, so only a small part of the charge on the capacitor is bled off.

The neon bulb in **Fig. 7** can be replaced with many types of rapid-turn-on devices such as the unijunction transistor or silicon controlled rectifier.

Cross coupling capacitors in multivibrators are not exactly timing capacitors. They do have a similarity however. The function of these is adequately covered in most of the texts on the subject. Suffice it to say that they serve both a timing and a coupling function. It is this combination of function that makes multivibrators possible.

Conclusion

This discussion makes no pretense of being all encompassing in the description of capacitor uses and associated current flow. The four uses mentioned do cover the great majority of cases in which this component is likely to be used in amateur equipment.

...WØHMK

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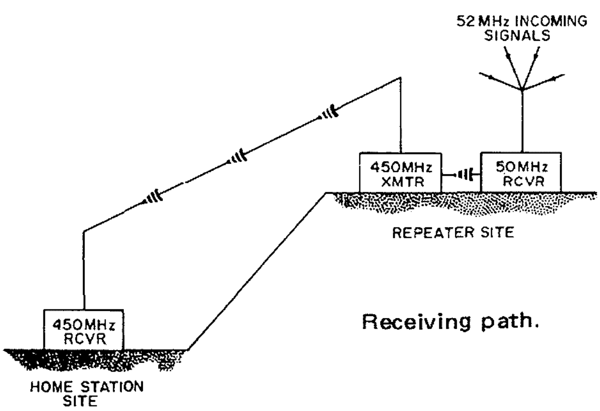
What About FM?

As I read through the many ham periodicals of the day, I am surprised at the absence of concern given to a field of amateur radio that seems to be growing by leaps and bounds, vhf FM. I have noticed a few editorials which share my concern.

Not many years ago, in the 1950's, amateur radio experienced what has been called by some, "the FM Fad." Whatever it was, it did bring to light some of the definite advantages of FM. These advantages include: it could be slope detected with an AM receiver, it often helped in the solution of TVI problems, large expensive modulators were eliminated, and a ham could run high power phone with an efficient class C amplifier. Not a bad list of advantages for any system.

Well, that was in the '50's, before SSB, selective receivers, inexpensive transceivers and linear amplifiers. Does this mean that FM is dead? Absolutely not! Now there is a new area open to FM. I probably should not say new, because it has been used commercially for years. This is vhf FM.



Receiving path.

Low and high band FM equipment has been available in varying amounts for many years as surplus. Three or four years ago when the FCC changed its specifications for frequency deviation there was a great deal of obsolete wide band gear available. Even today, with the big change over to transistors there seems to be a fair number of units on the market. This can be affirmed by the many amateurs who have this equipment on the air. I wish I could find some accurate figures concerning the number of amateurs using vhf FM, but I have not been able to do so.

I am not going to argue the merits of AM vs SSB vs FM, because I feel each system has its merits in the vhf spectrum. If the FM units have proven successful for commercial service, I am sure that the amateur can also use them successfully.

This equipment has been built by such manufacturers as Motorola, General Electric, Link, Raytheon, Comco, RCA, etc. These transmitter-receivers are generally well designed and trouble free. They contain sensitive many tubed or transistored receivers with efficient transmitters whose output ranges from 5 to 100 watts. Most of them are complete with power supply, either vibrator or dynamotor type depending on the transmitter power rating. Some of the newer units employ transistorized power supplies.

They are terrific for mobile installations. Since they are crystal controlled, all that is needed under the dash is a small control head and a mike. The XYL might appreciate that feature. The fact that the receivers are squelch controlled makes it easy on the

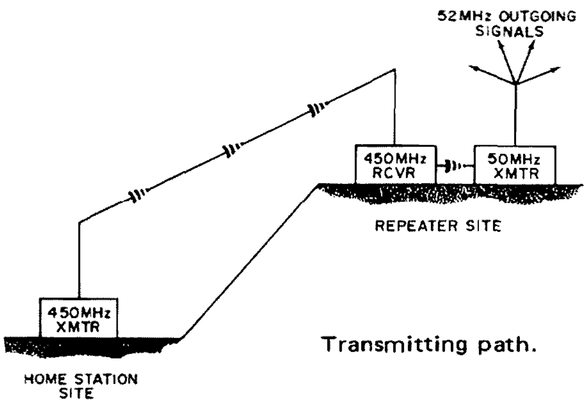
nerves; when there is no signal, there is no audio or noise. Because of the natural characteristics of an FM receiver, it limits AM, there is little ignition or pulse noise. If you have been a mobiler, you are aware of what a problem noise can be. VHF antennas for mobile use are simpler to install, smaller and more efficient than their big hf brothers. You can obtain a fine non-directional radiation pattern by placing a quarter-wave vertical whip in the roof of your car, a very difficult feat to accomplish in the hf spectrum.

There are presently two national calling frequencies, 146.94 mhz and 52.525 mhz. Depending on your local customs, there are several other channels being used, such as 52.640 mhz, 52.720 mhz, 146.670 mhz and 146.790 mhz.

Obviously, the fact that this equipment is crystal controlled makes it a natural for net operation. The receiver squelch system makes 24 hour a day monitoring practical. You can never tell when the six meter band will open. The receiver squelch can be easily adapted to operate a plate sensitive relay. This relay can operate lights, bells, or other electronic equipment.

Schematics and information on conversion of this equipment to amateur use is readily available.[1] This would make a good club or group project. If you can get one unit operating, you can use it as a signal generator or as a frequency meter. It would be nice if someone in the group had a good vhf signal generator or wattmeter.

There is also 450 mhz FM equipment available. This gear has possibilities as link equipment for remote repeaters (See diagram). For instance, a 450 mhz transmitter at your home in the valley could send a signal to a 450 mhz receiver on a hilltop many miles away. The squelch operated receiver could then turn on a six meter transmitter and retransmit the incoming signal. If you reverse the process, a six meter receiver on the hill can operate a 450 mhz transmitter and your 450 mhz home receiver will hear everything that can be heard at the hill on six meters. Other combinations are possible, six meters to two meters, 450 mhz to two meters, etc. The characteristics of FM, the squelch operated receivers, and the bandwidth of the vhf spectrum all combine to make repeater operation feasible. There are many of these systems in use today.



Transmitting path.

The repeater operation greatly increases the range of mobile units. Its uses for emergency and public service duty are almost endless. Think of the challenge of trying to get a rack full of this equipment working smoothly and then sitting back and watching all those pilot lights blink merrily and hearing all of those relays chattering noisily – beautiful – beautiful.

. . . W9VZR

[1] Sherman M. Wolf, *FM Schematic Digest* (Boston: Two-Way Radio Engineers, Inc.)

Ralph J. Irace, Jr., WA1GEK

A Primer on Radio Propagation

It has never been a secret that long-range communication in the amateur bands is primarily dependant upon the ionosphere, however it is essential to visualize the structure of the ionosphere and to understand more thoroughly the basic theory behind the usage of sky-wave methods of transmission if effective use of the ionosphere is to be made.

The Ionosphere's Structure

The ionosphere's overall structure consists primarily of three ionized layers ranging from 35 to 215 miles or so above the earth. The region lowest in height found at about 35 miles extending to 70 miles, is called the *"D" layer* and for all practical purposes, is useless to the amateur. Instead of reflecting radio waves, the D layer acts as an impediment and attenuates the signals strength to some degree, sometimes completely absorbing 160 and 80 meter signals while passing through its region either upward or downward after being reflected back to earth by another ionized layer. However, after darkness, the D layer is virtually a nonentity. The next ionospheric layer is known as the *"E" layer* and is found from about 70 to 175 miles above the earth. This particular region will reflect signals back to earth for a good part of the daylight hours however after darkness, it similarly vanishes like the D layer. Next in line upward is the *"F" layer* which during the daylight hours divides into two separate layers called the *F1* and *F2 layers,* and during night hours forms one single layer (F layer). The F1 layer is generally found at about 140 miles in height and extends to 200 miles where the F2 layer then makes its appearance. The F1, F2 and the F layer are able to reflect signals back to earth in the order of a thousand up to several thousand miles depending upon the angle of radiation. These particular layers are useful for both day and night, although daytime usage of these layers is relatively "lossy" due to the presence of the D and E layers. Night time communication is especially good, mainly because of little loss and prime conditions. Also of importance to mention is the often encountered "sporadic E" ionization layer effect which is found invariably in the same height as the E layer. This rather unusual as well as unpredictable layer can be found both in the day and night hours, although more prevalent during daylight time, and it is found generally at all latitudes. It can be best visualized as intermittent clouds relatively dense in ionization in which its ionization level may change its intensity from hour to hour. It is of use to low band work and accounts for most short distance communications and when intense enough, it can be a heaven for 6 meter enthusiasts though its bearing on vhf operation will be discussed more thoroughly later on. These various layers are illustrated in **Fig. 1.**

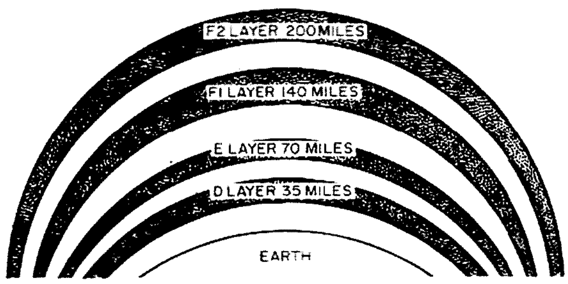
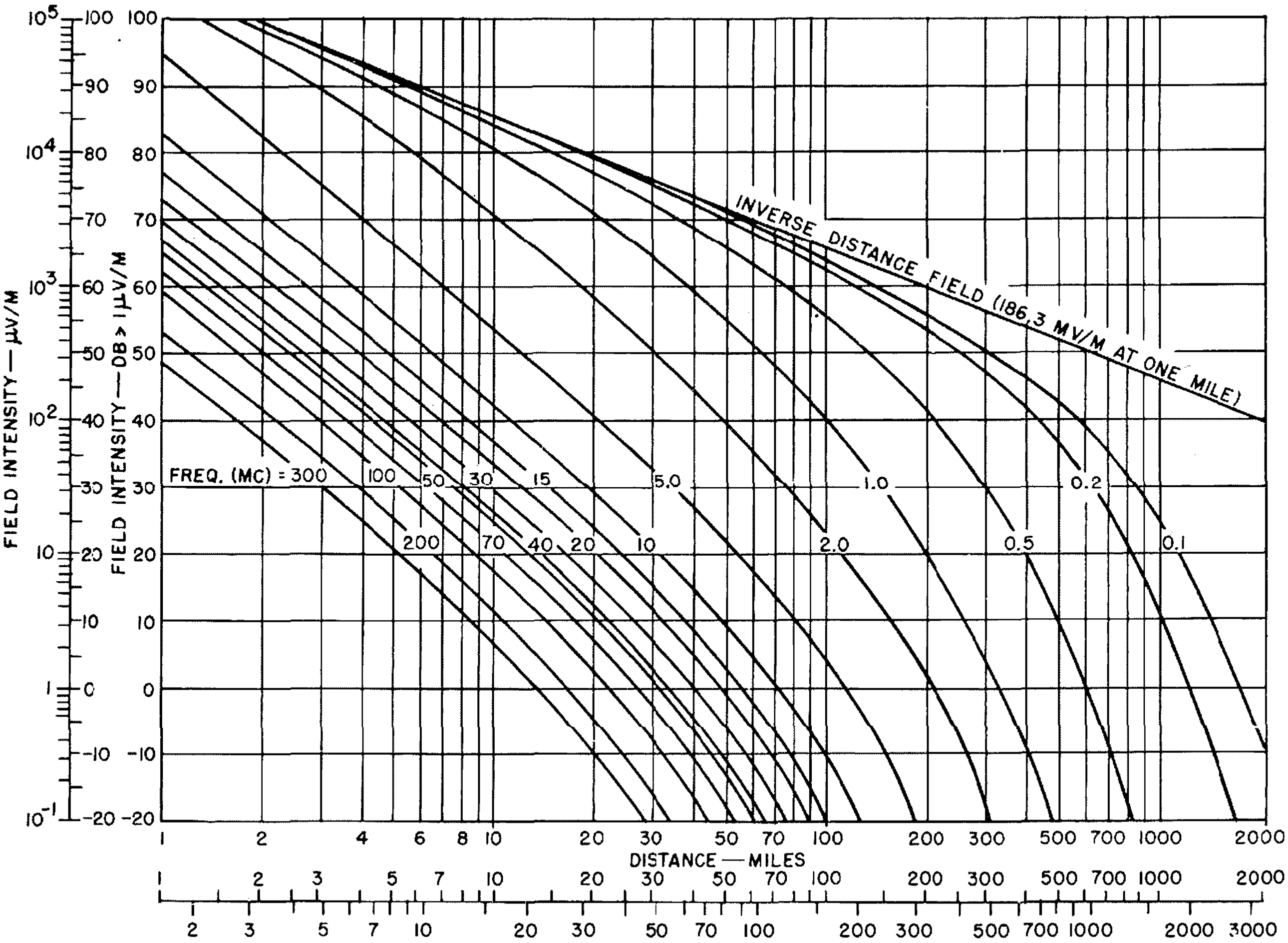


Fig. 1. Illustration of the ionospheric layers as they would appear during daylight hours.



Source: National Bureau of Standards

Fig. 2. Graphic chart illustrating the typical groundwave field-intensity curves for 1 kilowatt of rf power radiated from a short vertical antenna at ground level assuming a "good earth" path.

Different Modes of Radio Propagation

When electromagnetic waves are emitted from an antenna, they can take either one of two possible types of communication processes: groundwave or skywave. The former method of transmission is used for relatively short distances and is heavily dependant upon the path it takes wherein the signal travels. Groundwave transmissions are subject to what can become a severe signal attenuation by a phenomenon known as "shadow loss".[1] This occurs when signals are unable to bend around natural or manmade obstacles or structures. Increasing your antenna height as well as the power can at times overcome some of these barriers, although a portion of the signal will nonetheless most always be attenuated to some extent. See **Fig.** 2 for a graphic chart illustrating typical groundwave field-intensity curves for radiation over a good-earth path. Skywave transmission is simply explained as having a large (or moderate, small) portion of your total radiation from the antenna directed up toward the ionosphere. For reasons already obvious, skywaves may be (1) completely absorbed in one of the ionized layers, (2) reflected back to earth, or may (3) go through all the ionospheric regions and on into space. See **Fig.** 3 for a typical field-intensity graph relating skywaves.

Other Factors

High-angle signals are those in which the actual angle of direction upward is so high that the layers sometimes don't have the ability to reflect them back to earth. The highest angle of radiation in which a signal is returned downward toward earth is called the critical angle. Similarly, if we transmit a signal on 40 meters and it is reflected back to earth, we could then switch to a higher band, say on 20 meters, and so forth up the frequency ladder until we reach a certain frequency in which the signal isn't reflected back by the ionosphere and instead is permitted to continue into space. This particular frequency is known as the critical-frequency and it varies with each

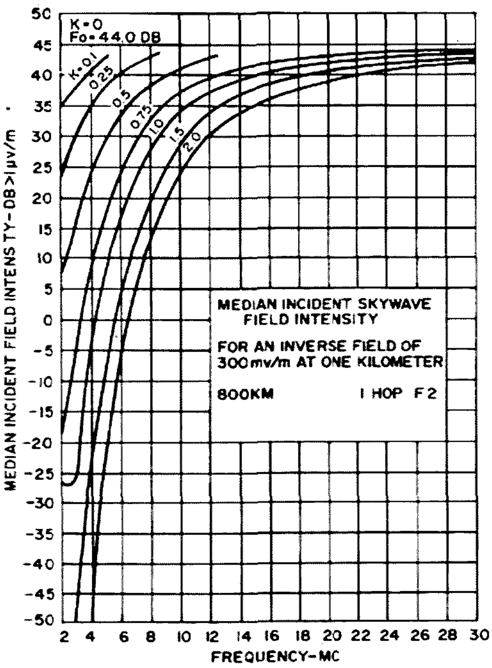


Fig. 3. A typical field-intensity graph for incident skywaves. The appropriate adsorption-factor K is used to predict the received field strength in μv/meter (microvolts excited per meter of antenna length). The curves show the variations in received field strength for a kilowatt of rf power radiated from a dipole antenna. Corrections are required for different power outputs and antenna gains.

different inonspheric layer and usually increases with the height of a layer. With reference to the critical angle again, as the angle of radiation is diminished, the radio waves return to earth at increasingly greater distances as illustrated in **Fig. 4.**

Suppose we then lower the angle of radiation and repeat a gradual increase in frequency. As we continue to lower the angle and simultaneously increase the frequency, we'll find that we can transcend the critical frequency while still retaining a back-to-earth reflection. However, we eventually come to a frequency where despite the lowest possible angle of radiation, our signal is not returned to earth. This is known as the maximum usable frequency (muf).

Next, we come across what is termed path absorption (or just absorption). While a radio wave is traveling through an ionized layer, some of its energy will be dissipated into that particular layer. Path absorption is directly proportional to an absorption factor K, used in the following equation: $K=T \times M \times S^2$ where T stands for the time-of-day correction factor, M corrects the seasonal variations in the ionization level or the layer, and S signifies the solar activity

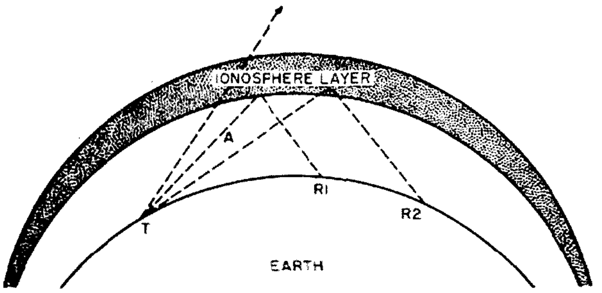


Fig. 4. Illustration of the critical angle. Any wave angle above wave A is beyond the critical angle and will not be returned to earth. As the wave angle is lowered, greater distances are possible.

correction factor based on the current sunspot cycle. The National Bureau of Standards regularly issues charts and tables to which this formula can be applied to; however, we will discuss this later.

Of equal importance are conditions in which signal reflection back to earth is at its maximum and minimum. As a rule, the larger the wavelength, the lower the radiation angle and the better the reflection (also called refraction). Also, the greater the intensity of an ionospheric layer, the lower the angle a signal is bent back. When the ionization intensity is at a relatively low level, the higher frequencies may not be reflected back to earth at all whereas the lower frequencies (3.5, 7 mc) could still be used for effective communicating purposes. For this reason, the lower frequencies are generally more dependable than higher frequencies.

Skip

When a signal is emitted from point A and is returned via the ionosphere to point B, the distance between those two points is called the skip distance. There will almost always be some amount of useful groundwave distance on a skywave signal, though usually only a fraction of the skywave skip distance. From the point where useful groundwave transmission begins to terminate to point B where the signal was reflected back to earth, we have what is known as the skip zone. Signals occasionally upon returning back to earth are reflected by the earth itself up to the ionosphere and subsequently bent back to earth again. This type of process is called multihop transmission, and it may repeat itself several times. However with each encounter of the ionosphere and earth, energy from the signal is absorbed and consequently the signal's strength diminishes with each "hop." See **Fig. 5** for an illustration.

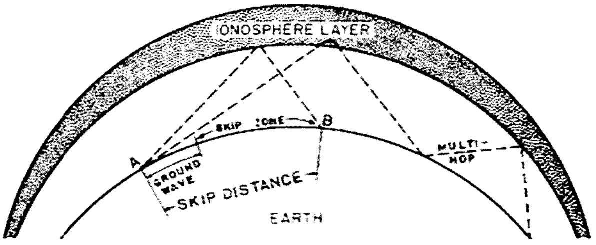


Fig. 5. The distance from Point A to B is the skip distance and from the ending point of groundwave transmission to point B we have the skip zone. Multihop transmissions are frequently occuring at all seasons of the year.

Sunspot Cycles and Ionospheric Variations

Ultraviolet radiation from the sun is believed to be the source of energy which ionizes the ionospheres numerous layers. This belief is constituted on the basis of what is known as the 11-year sunspot-cycle. Over a period of a few years, the number of sunspots increases to a peak and then gradually declines. The duration from one sunspot peak to another usually covers about 11 years. During its peak, communicating conditions are excellent especially for 20, 15 and are even better on 10 meters. We are approaching a sunspot peak now and therefore world-wide contacts should be at their best before very long. At a sunspot minimum or "sunspot dip," communicating ranges are poor with very few band openings. There also exist what is known as ionospheric storms, and when they occur, the critical frequencies drop considerably and absorption of radio signals in the ionosphere is substantially increased. These ionospheric storms are resultant of certain sunspot activity. They usually last from a few hours to several days.

The critical frequencies vary with the seasons as with the days. During the summer, the E layer maintains a higher critical frequency as does the F1 layer. Conversely, the F2 layer's critical frequency peaks occur during the winter months and are at a minimum during the summer.

vhf Propagation Characteristics

Many amateurs are inclined to believe that the several types of low-band propagation effects are equally present on the vhf frequencies. This is not so. The vhf bands have rather unusual propagation phenomena which is most certainly very effective at times. The first of these is known as tropospheric bending and it's brought about by changes in the humidity and temperature in the lower atmosphere at altitudes of about 4500 feet. This type of effect is occasionally present on 28 mc but in the majority of cases is more prevalent and potent on 50 and 144 mc, usually more pronounced on the latter frequency. Another phenomena is the aurora effect. Frequencies below 30 mc are severely attenuated while those above are favorably propagated when an aurora occurs. However, the auroras have a tendency toward sustaining a flutter or rapid fading on signals and for this reason, phone operation during these effects is usually unreadable. Many amateurs resort to cw when there is an aurora opening while most phone operators find themselves struggling. Best results can be obtained by directing your beam toward the aurora display itself found in the northern latitudes. Sporadic-E skip, although used to some extent on the lower bands for short distances, is most often responsible for ranges in some instances up to 1,400 miles on either 50 or 144 mc, although the effect is much more pronounced on the former frequency. F2 layer skip is best at the peak of the 11-year sunspot cycle and can easily propagate a 50mc signal to distances exceeding 2,000 miles. Thus, worldwide communications are possible. F2 layer skip was responsible for the first transatlantic QSO on 50 mc on November 24, 1946.

Both forward and back scatter are also effective means of propagation. The former type is more widely found in the vhf and uhf regions, and back scatter usually only on 50 mc (and the lower-bands). These two types of scatter are present in both the troposphere and ionosphere. Tropospheric forward scatter usually produces distances up to 400 or so miles on 50 mc; ionospheric forward scatter has ranges of 500 to 1300 miles attributed to it. Back scatter most often occurs when either sporadic-E or F2 layer skip is taking place. At the bottom of the totem pole we have the most intriguing and challenging of all vhf propagation methods, known as moonbounce, irregularly referred to as "lunar communication." In order to have a successful QSO via moonbounce, one must possess the absolute ultimate in receiver performance, mass arrays of high gain beams or a large parabolic reflector of helical type antenna in addition to a large amount of transmitter power usually on the order of one kilowatt or just a little less, not to mention the technically correct type of antenna-rotation polarization, tremendous receiver and transmitter

stability amongst other factors. Some amateurs who have these prerequisites for effective moonbouncing have had their signals reflected back to earth at frequencies exceeding 1,200 mc! However, only the amateur who can afford such immense requirements and who is technically competent of undertaking such an effort should try any moonbounce work.

Propagation Data

If the amateur has in his shack a wealth of propagation charts or just one or two of them, he will be much better off than the other amateur who doesn't have any. By subscribing to the Institute for Telecommunication Sciences and Astronomy, you can be put on the mailing list to regularly receive their monthly prediction charts if you are interested in predicting muf's for the upcoming months. The subscription rate is $2.75 annually or you can purchase these charts separately for 25 cents apiece.

. . . WA1GEK

References

1, 2 "Radio Propagation and the Amateur Radio Operator," H. Jones, *Ham Tips*, Winter, 1964-65.
3. "ARRL VHF Manual," E. P. Tilton, 1st edition, p. 11, Charts from the National Bureau of Standards.

Measurement of Percentage of Modulation of an AM Transmitter

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Did you ever need to know how well a plate-modulated AM transmitter was being modulated and could not make this measurement for lack of an oscilloscope or a modulation percentage meter? Well, here's a way to make this check which works surprisingly well, considering its simplicity. All you need is a VOMA and a 0.1 ufd capacitor which has voltage ratings greater than twice the plate supply voltage to the final *rf* amplifier. Some VOMAs are equipped with an output range, which simply inserts a capacitor in series with the ac scales. This range may be used in lieu of the series 0.1 uf capacitor if the voltage range is sufficiently high.

The percentage of modulation of an AM signal is:

$$\%\ \text{Modulation} = \frac{100\ E_{\text{max rf}} - E_{\text{min rf}}}{E_{\text{max rf}} + E_{\text{min rf}}}$$

$$\text{or approximately} = \frac{\text{ac Modulation Voltage}}{0.007 \times \text{dc Plate Voltage}}$$

It will be convenient, but not necessary, to have a milliameter in the final amplifier plate circuit. To make the simple hook-up, proceed as follows: With the transmitter de-energized locate the junction point "X" in **Fig. 1**, between the modulator output and the dc input to the modulator amplifier. The voltage at this point is dc plate voltage with ac modulation voltage superimposed on it. To measure percentage of modulation, these voltages will be separated and used in the simplified equation.

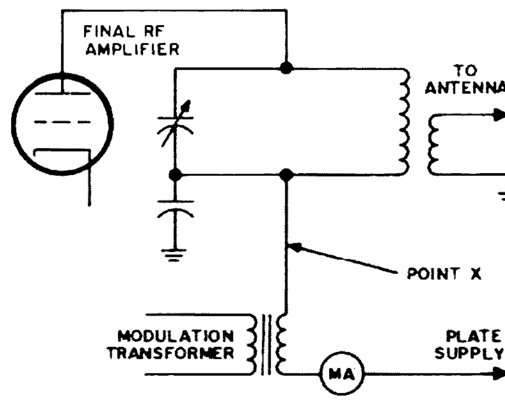

Fig. 1. At point "X" the voltage is dc plate voltage with ac modulation voltage superimposed on it.

Connect the VOMA between chassis ground and the junction located above and set the meter to dc volts. Energize the transmitter and load it into an operational antenna or into a dummy load for bench testing. See **Fig. 2.**

Now, modulate the transmitter by talking or whistling into the microphone. The plate current to the modulated amplifier should not change appreciably under modulation. If no plate current meter is available, the VOMA, which is now connected into the circuit, may be used as a rough check on plate current stability. An increase in plate current will cause an increase in the voltage drop across the power supply impedance, and a corresponding drop in the voltage read on the VOMA. A decrease in plate current will cause an increase in the voltage read on the VOMA. These changes will not be large and you will have to use care in making this reading.

Any change in plate current to the *rf* amplifier indicates trouble and must be corrected before proceeding. Changes in plate current may be caused by any one or more of the following troubles: Insufficient

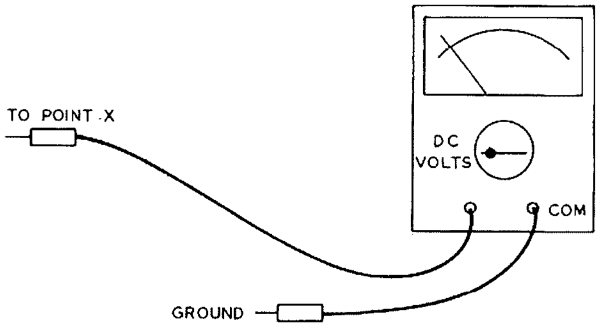

Fig. 2. Meter at dc volts.

rf drive to the final amplifier; a flat final amplifier tube; a flat rectifier in the power supply to the final amplifier; improper tuning and/or loading of the final amplifier; improper neutralization of the final amplifier (many pentodes require neutralization when operated in the vhf range); parasitic oscillations; modulation exceeding 100%.

A word of caution: transmitters employing exalted carrier or so-called range gain operation will normally show an increase in plate current during modulation. This simplified method cannot be used with such transmitters.

When necessary corrections are completed and no significant changes in plate current are evident, you are ready to measure percentage of modulation. Note the dc voltage reading and jot it down. De-energize the transmitter. Connect the 0.1 uf capacitor in series with the VOMA lead and reconnect to the test point. Set VOMA to ac volts. See **Fig. 3**.

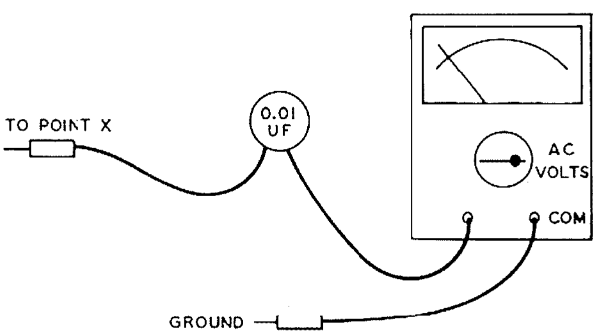

Fig. 3. Meter at ac volts.

Re-energize the transmitter and, using the microphone, modulate the transmitter with a slow steady count or a long sustained whistle. Note the peak values of the ac modulation voltage indicated by the VOMA.

The percentage of modulation of the transmitter is equal to:

$$\frac{\text{ac modulation voltage}}{0.007 \times \text{dc plate voltage}}$$

Typical values of modulation as measured on a Heath Two-er are:

Normal voice with microphone 3" to 6" from mouth.	Fluctuating 30% to 70% with peaks to 100%
Long sustained whistle into microphone	Steady 50% to over 100% depending on loudness of the whistle.

Modulation appreciably less than these values can indicate trouble and should be located using standard trouble shooting techniques.

Should you need measurements more definitive than can be obtained by whistling into the microphone, substitute an audio signal generator for the microphone. Using a shielded cable, connect the output of the generator to the microphone input of the transmitter through a resistor equal in value to the microphone impedance, and set the signal generator output level to the sensitivity rating of the microphone. Typically, a series resistance of 50,000 ohms and a signal level of -55 to -45 db one volt at a frequency of 1,000 cycles per second should be used.

Although a parallel tuned *rf* tank circuit and a transformer type modulator is shown in the sketch, the same measurements can be made on amplifiers using Pi-networks or series tuned tank circuits and Heising or choke type modulators. Simply locate the junction point between the modulator output and the dc input to the modulated amplifier and proceed as above.

A final work of caution: The voltage at this junction can be lethal and since you are using a new technique, be extra careful to de-energize the transmitter and to short out the power supply before you make or break the connections to the junction point.

. . . Willard S. Granger

STAFF

Getting Your Extra Class License

Part VIII – Band Widths

In the preceding installments of this Extra Class study course we have attempted to concentrate upon a single primary subject each month, covering as many questions from the FCC study list as possible within the confines of that subject.

We'll do so in the future, too – but this month as a change of pace we're doing things a little differently. The reason is partly due to comments we've received from you, partly due to some relatively recent additions to the original study list which add questions not completely covered in prior chapters, and partly because this month's subjects are themselves a little different from the normal course of events.

In electronics, as in all study of physics and similar things, we take certain "facts" for granted. Once we've all agreed to do this, nobody bothers to examine those facts any more – but many of them can stand some examination. And that's what we're up to this time around.

In the process of examining some of these "obvious" matters, we'll hopefully reach a position to know the answers to the following questions from the Commission's list of study questions for the Amateur Extra Class Examination (the numbers are those appearing on the official list):

80. What must the value of an inductor be to cancel a capacitive reactance of 12.6 kilohms at an operating frequency of 2 Mc/s?
82. What are the bandwidths normally used for A1, A3 (single and double sideband), and F3 (narrowband) type emissions?
88. How does a frequency converter operate?

You may feel that we are short-changing you this time by dealing with only three of the FCC questions – but read on. These three are all based on some of those taken-for-granted facts which turn out, upon close examination, to be far from obvious.

As always, we won't attempt to obtain direct answers to the FCC questions. Instead, we'll pose some new questions which cover the basic principles involved, but which include some implications of the basics which are omitted from the specific study questions.

For instance, FCC question 80 deals with most specific values of inductance in a single case – but to answer it we must be familiar with most of the basic principles of ac theory. We've already gone into this quite a way (in the first installment of this series and the final installment of our previous study course on the Advanced ticket) but one area of it we have omitted in the past: that is the question of obtaining proper Q in the resulting resonant circuit, and the allied question of picking the proper LC ratio for the circuit. In the FCC question neither of these questions is pertinent – but in any practical application of the theory involved, either of them may mean the difference between success and failure of the project.

So our first question will be "How Can We Optimize a Resonant Circuit?" This should wrap up both the points our previous discussions have missed, and assure a more complete understanding of the important facts of resonances.

Similarly, FCC question 82 deals with bandwidth. We may not go quite all the way to the basic question of what bandwidth amounts to, but we will try to resolve the paradox that a carrier with no bandwidth at all can be used to transmit a signal which occupies quite a considerable chunk of the band, yet is itself composed simply of many single frequencies, none of which have any bandwidth of their own. See what we mean about things getting sticky when we question the "obvious"?

But we'll try anything once, so we'll ask – and attempt to answer – "How Can a Signal Exist Without Taking Any Space?"

Assuming that we'll come out of that one

satisfactorily, we'll move right on to the second basic principle involved in question 82: "Why Do Signals Require Bandwidth?"

Question 83 deals with the operation of "frequency converters" but most of us think of these devices under the name "mixers" instead. We've all been told by Authorities that any non-linear device can act as a mixer, and that any mixer must be non-linear. Few of us have had the gall to ask publicly "Why is it mandatory that a Mixer be Non-Linear?" For our final question this time out, we propose to remedy that situation – and ask why.

All set to dive into this potential mess of confusion? Leave your prejudices behind, get all set to adopt some unusual viewpoints, and we'll jump right in.

How Can We Optimize a Resonant Circuit? Virtually all radio communication involves the use of resonant circuits in one way or another. Any tuning element involves resonance; without it we could neither transmit a stable signal, nor could we select the desired signal with our receivers. In the earliest days, when big spark gaps furnished the transmitted *rf* and mechanically-shaken coherers were the receivers, resonant circuits as such were unknown – and radio's usefulness was sorely limited.

We don't have the space to repeat our two earlier discussions of impedance, reactance, and their effects upon resonance; we'll have to assume that you've already gone through them and are willing to agree that the condition of resonance exists whenever a capacitive reactance and an inductive reactance are canceling each other out in a circuit.

However, if you're designing the circuit in the first place, and your major requirement is to obtain resonance at some single desired frequency, you have an infinite number of values of reactance to choose from! No matter what size of capacitor you may choose to use, it will have a definite capacitive reactance at your desired frequency, and all you need to achieve resonance is to provide an inductive reactance of exactly the same value at the same frequency.

There are, of course, some practical limits. You wouldn't normally want to try to resonate a 100-mfd capacitor at 432 mhz, because its capacitive reactance would be so small that any physically achievable inductor would probably be too large to resonate. Similarly, you wouldn't try to tune a 10-pf capacitor to resonate at an audio frequency, because the required coil would have to be far too huge and cumbersome.

But even within the practical limits you still have an infinitely variable range of choices. To tune a circuit to 4 mhz, for instance, you might use a capacitor as large as 5000 pf, or you might choose one as small as 10 pf for the job.

Once you do choose a capacitor, your inductor's value is immediately set by the frequency at which resonance is required. This is a natural consequence of the definition of resonance; whatever the reactance of the chosen capacitor at the desired resonant frequency, the coil must be of the precise value to provide the same amount of inductive reactance at that same frequency.

A little playing around with the reactance equations turns them into an interesting statement which involves only L, C, and f; the square roots and 2-Pi terms of the reactance equations vanish to leave only: $LC = 25{,}330/f^2$, where f is frequency in mhz, L is inductance in microhenries, and C is capacitance in picofarads.

The value you get when you plug a frequency into this equation is known as the "LC product"; for the example we used above of 4 mhz, the LC product is 25330/16, or 1583.125. This means that if we choose a 5000-pf capacitor, our coil must be 1583/5000 microhenry; if we choose a 10-pf capacitor, our coil must be 1583/10 microhenry.

The LC product is constant for any one frequency – but the LC *ratio* is not. The LC ratio is not completely defined, but in general it's the ratio of inductance to reactance within the circuit. If we used a 5000-pf capacitor with an inductor of approximately 0.317 microhenries (1583/5000), the LC ratio would be 0.317/5000 or 0.0000634. If we used a 10-pf capacitor with a 158.3-microhenry inductor, the LC ration would be 158.3/10 or 15.83. You can see that even though we stay within practical limits with our choice of C, the LC ratio varies over a four-million-to-one range.

And what we're setting out to determine here are the factors involved in your making that choice from the wide range of possible LC ratios.

You probably will never be able to make the exact choice; such things as stray capacitance get into the act, so that the final circuit is only an approximation to the values you worked out on paper in advance. This is the reasoning behind the popular

technique of simply choosing a value at random, and tuning the coil by use of a grid dipper so that it resonates at the desired frequency.

And while such a rough-and-ready approach can always get you a resonant circuit, the results may not be nearly what you expected; even though the final version must always be trimmed in to the proper value, it's best to at least be in the right county before you start the cut-and-fit process.

The main factor involved in choice of an LC ratio is the desired impedance of the resulting resonant circuit. All other factors remaining equal, a tuned circuit with a low LC ration (little L, high C) has relatively low impedance while one with a high LC ratio has high impedance. Thus for use with a transistorized amplifier you would want tuned circuits with low LC ratio, while for use in a Class A amplifier with vacuum tubes a high LC ratio might be preferable.

However, this is very much an over-simplification, because of those "weasel words" "all other factors remaining equal." The fact is that all other factors *cannot* remain equal. In any tuned circuit with moderate to high Q – that is, with a Q of 10 or higher – the impedance of the circuit at resonance will be Q times the reactance of either the coil or capacitor alone. The kicker is that the Q of the circuit is defined as the ratio of inductive reactance to series resistance; if we keep the series resistance constant, then as we reduce the L and increase C to work toward a lower LC ratio we will at the same time be reducing the Q, and so reducing circuit impedance more rapidly than we would desire.

Similarly, with constant series resistance, increasing L and reducing C to get a higher LC ratio will at the same time increase the Q, and multiply circuit impedance more rapidly than we would expect.

But we can't hold series resistance constant either, because it's really just a tidy mathematical way of accounting for the circuit's losses – and most of the losses are in the coil. This leads to a rule of thumb that the lower inductance coil has lower losses; Q may then remain constant, or may even increase as we lower the LC ratio. If we move toward a higher LC ratio, we may actually reduce Q so that the expected increase in impedance is somewhat cancelled out by a reduction in circuit Q.

Because there *are* so many variable factors involved – not the least of which is

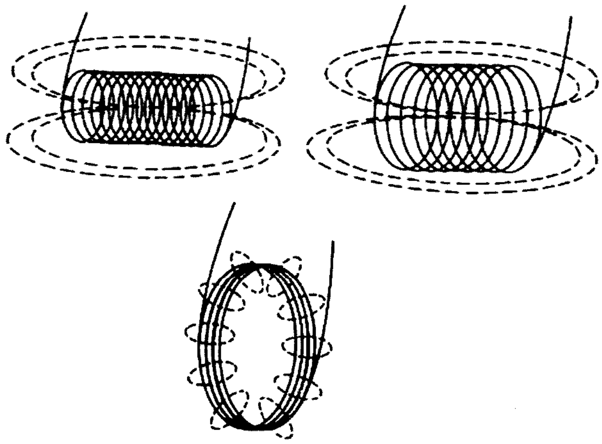

Fig. 1. Q of coil is ratio of energy stored in coil's magnetic field to energy dissipated in coil's resistance and radiation losses. Long thin coil, at left, requires more wire and so has higher resistance while at the same time producing smaller magnetic field. Large short coil, right, also has smaller magnetic field and because of its size is more subject to radiation losses. "Square" coil, center, strikes balance between large magnetic field for energy storage and small enough size to minimize radiation, and so has optimum Q.

the problem of winding a coil to a specified Q value – we don't have any precise rules for choosing the optimum LC ratio. All we can go on are some rules of thumb: the lower the LC ratio, the higher the Q is likely to be. This increase in Q usually does not prevent the low-LC-ratio circuit from having lower impedance, but it may turn out to be sharper in its tuning than expected. A high LC ratio, on the other hand, tends to produce less selectivity but a higher impedance. If a coil of known Q is available, the coil rather than the capacitor can be used to set the LC ratio with considerably more accuracy than if the capacitor is chosen first.

We've talked quite a bit about this factor "Q," and even defined it as "the ratio of inductive reactance to series resistance." Actually, it has quite a bit more meaning than that:

The symbol "Q" comes from the phrase "quality factor," and originally the only use of "Q" was as a figure of merit for different coils. Under those conditions, the reactance-to-resistance ratio definition was more than adequate; the more resistance in a coil of given inductance, the lower its Q and presumably the lower the quality as well.

But when a coil is combined with a capacitor to form a tuned circuit, then the entire circuit has its own Q factor, which is not always the same as that of the coil although the coil Q is the largest single

influence on the circuit Q in the absence of any loading or deliberately introduced resistance.

And since the Q of the circuit is not necessarily totally set by the Q of the coil, the simple reactance-to-resistance definition may not always apply; it will never apply unless we also assume that all of the losses in the circuit are concentrated in the coil as a part of its "resistance."

This extended meaning of "Q" can be covered by redefining Q as the ratio of peak energy storage in the circuit to average power loss; an alternate wording of this definition is the ratio of peak energy stored to energy dissipated per cycle. The "energy stored" referred to in these definitions is that which alternates between magnetic and electric fields to provide the "flywheel" effect of the resonant circuit, and the "energy dissipated" or "power loss" is that energy which is lost by being converted to heat energy.

While this definition of Q is considerably more abstract than is the simple "X/R" ratio with which we started, it not only includes the simpler version as a special case but covers many of the effects usually associated with high-Q or low-Q circuits.

For instance, it's a generally accepted idea that a physically large coil will have higher Q than will a smaller coil of the same inductance. This happens because the larger coil has two things going for it: its larger size permits it to create a larger magnetic field for energy storage, and also reduces built-in resistance so that less energy is lost.

It's also generally accepted that a "square" coil – that is, one whose diameter is the same as its length – has higher Q than does a coil of any other proportions. The reasons for this are a little harder to see, though, because many things are working at the same time and the final result is a balancing of all of them. The inductance of a coil depends, among other things, upon the magnetic linkages between turns; this means that the more turns, the greater the inductance because there are more linkages. Q, on the other hand, is influenced by physical size. To carry these two ideas to extremes, a coil could have very small diameter and many turns, or very large diameter and only a few turns. Between these two extremes, the huge coil with few turns would have higher Q – but when the coil gets sufficently large, it begins to lose energy by radiation, and this is "energy lost"

just as much as if it were converted to heat. The result is a decrease in Q.

As the diameter of a coil is increased, for any specific value of inductance, the length must decrease to keep the inductance value constant. This raised Q by increasing physical size. By the time the coil reaches the "square" proportion, though, the increase in Q gained by any additional diameter increase is very small, and the accompanying decrease in length actually reduces the amount of energy storage space available. Any increase in diameter beyond the "square" proportion then begins to reduce the Q – and that's why square coils normally have higher Q than those of any other proportion. Of course, anything which tends to add losses, such as shielding or lossy coil forms, will reduce Q, so the comparison doesn't mean that a poor square coil is of higher quality than a good non-square one.

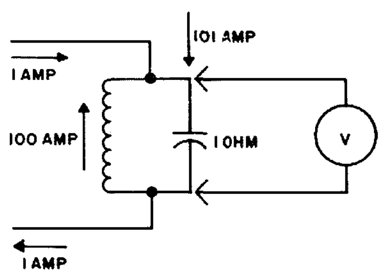

Fig. 2. Voltage drop across any single impedance in a resonant circuit is affected by Q as shown here. This circuit has Q of 100 since 1 amp of current overcomes losses to maintain 100 amps of circulating energy. If impedance of capacitor is 1 ohm, voltmeter will measure 101 volts across the capacitor, although only 1 amp is flowing in external portions of circuit. Meter impedance must, of course, be taken into account since it will load circuit and effectively reduce Q.

What about some of the other implications of Q? For one thing, as the ratio of energy stored to energy lost per cycle, it defines the ratio of *circulating energy* to *driving* energy in a resonant circuit. To keep energy circulating, the external energy source must supply enough driving energy to exactly overcome the losses. When this much energy is supplied, then Q *times* this much energy will be circulating. If we look at this energy, as for instance by measuring the voltage drop across either the coil or capacitor, we can see it as a "multiplication factor." If we feed such a circuit with 1/2 volt, and circuit Q is 100, we will measure 50 volts across the circuit as a whole.

Of course, our measuring device must take out some energy in order to make the

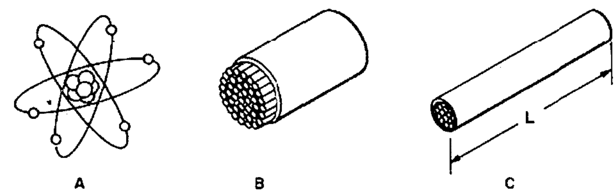

Fig. 3. Physicists tell us that atoms consist of nucleus surrounded by orbital electrons (A), and all materials are made up of atoms (B). If this is the case, absolutely precise measurement of the length of a piece of wire is impossible (C) because the length varies plus of minus the diameter of an atom as the electrons orbit the nucleus. This doesn't keep us from making useful and "accurate" measurements, but it does point up the sharp dividing line between the absolute precision of any theory and the slight uncertainties we face when we apply that theory to the actual world around us. "Measurement" is a part of the real world; and the idea of "length" belongs to the world of theories. In most cases they are close enough to each other to permit us to consider them as identical—unless we insist on "measuring" something with no error at all!

measurement, and this energy is lost to the circuit. This means that the circuit Q is lower when we're measuring than when our voltmeter is disconnected, and the figures in the previous paragraph are correct only if Q is 50 with the meter connected.

This point is important, because it involves the practical applications of most tank circuits. A vacuum-tube grid, operating Class A, is next to nothing in its loading effects, and so a Class A amplifier has little effect upon the Q of its tuned grid circuits. A plate circuit, on the other hand, is a relatively low resistance and will load a tank circuit heavily. This is why final amplifiers, for example, are designed to operate at Q values between 5 and 20.

We could continue examining Q and its implications for many times the length of this article without exhausting the subject. It's a key factor determining the selectivity of a tuned circuit; it determines, almost by itself, the stability of an oscillator; it is related very simply to the power factor of a circuit (which is approximately 1/Q); to mention only a few of its other meanings. But we have other subjects to explore.

How Can A Signal Exist Without Taking Any Space? Open any text you like which discusses the bandwidth requirements for radio transmission, and sooner or later you'll come across the statement that "a carrier has no bandwidth."

How can you have nothing from something? Pick any carrier at random; you

can see it on a spectrum analyzer, get an FCC citation for off-frequency operation, convert it to an audio frequency which you can hear, see it hold up an S-meter needle. How can this have no bandwidth? Obviously it must exist, and if it exists then it must be somewhere. And if it *is* somewhere, then that somewhere must take up at least a little spectrum space no matter how small. But if it takes up any space then that space is its bandwidth, and the authorities say the bandwidth is zero. Therefore it occupies no space, and since only the non-existent can fit into "no space," the carrier must not exist!

Most of us who first get tangled up in that self-contradicting line of reasoning cited in the previous paragraph conclude that the authorities who say bandwidth is zero are wrong. If the statement "a carrier has no bandwidth" is changed to read "a carrier occupies so little bandwidth that it cannot be measured," then the contradictions vanish. For all practical purposes, the two statements are equivalent – but the minute difference between them permits the carrier to exist.

Unfortunately, this simple answer to the paradox is wrong. A perfect, ideal carrier actually does occupy *zero* bandwidth, and this statement does not rule out the possibility of such a carrier's existence. No one has yet created one, and the chances of it happening at any time in the future are incredibly small (it's much more likely, for instance, that all the water molecules in the Pacific Ocean will move in the same direction in the same instant, thereby putting the entire ocean into orbit and exposing its muddy bottom), but that's not because of the zero-bandwidth requirement. Quite a few practical carrier signals have unmeasurably small bandwidths.

The paradox involved in the zero-bandwidth question is that involved in all measurements. *No* measurement can ever be accurate, to zero tolerance. No matter how much we refine our equipment, for instance, can we be sure that a piece of wire is precisely one inch long – because it may be the width of an electron less than one inch, or greater, depending upon precisely what instant we measure it! And if it's either, then it's *not* precisely one inch.

This may sound like splitting hairs. Actually, splitting hairs is a rather imprecise operation compared to the idea we're attempting to explore. What we're really looking at is the difference between absolute precision, and possible achievement.

Absolute precision may exist somewhere in the Universe, but we could never recognize it even if we stumbled across it. The only place it has any use for us is in the theories which we evolve in our attempts to explain why things happen as they do.

But the theories *must* be framed in terms of absolute precision. When we look at Ohm's law, for instance, we find that $E = I \times R$; this is precision. It does *not* say that E is approximately (almost I) times (somewhere very near to R) – but any attempt to put the law to use will have to make use of *approximate* quantities for I and R, because we cannot measure any other kind.

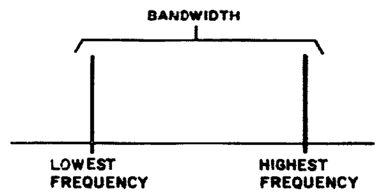

Fig. 4. If we assume that any single frequency is just that—a single frequency—then it cannot be any other frequency. Any practical signal contains several different frequencies, and a group of frequencies all taken together is called a "band." The bandwidth of this band is simply a measure of the difference between the lowest frequency in the band and the highest. In the case of a single-frequency carrier, only one frequency is present and it is both the lowest and the highest, so that the "bandwidth" of that single frequency must be zero. Note that this doesn't say that the single frequency doesn't exist; it merely says that no other frequency is associated with it.

And that's why a carrier has zero bandwidth. The carrier exists; we can observe its effects. Bandwidth, on the other hand, is an idea straight out of the world of theory. It is defined only in theoretical terms; it's the amount of spectrum space between the lowest (not the approximately-lowest) frequency in the signal and the highest (again, not the approximately-highest). A carrier is a single frequency, and so it is at the same time both the lowest and the highest frequency in its signal. The result – theoretical, of course – is that carrier minus itself equals zero, and the carrier has zero bandwidth.

Any practical carrier we put on the air is likely to have at least a little modulation upon it, though. It's most difficult to get all the hum out when we use ac upon the filaments of the transmitter. This hum may be so far below the carrier in amplitude that we cannot tell it's there – but if the carrier's frequency ever varies by so much as one

ten-millionth of a ten-millionth of a cycle per century, then there's a "lowest" frequency and a "highest" frequency which are *not* equal, and that carrier will have a non-zero bandwidth. In the rather extreme case just cited, the bandwidth would be somewhere in the neighborhood of 0.00000000000000001 cycle per year, or 0.00000000000000000000076 hz (give or take a few). This is an extremely small number – 0.76×10^{-21} – but it's still infinitely greater than absolute zero!

Now when we look at a carrier on a spectrum analyzer, it appears to occupy a definite bandwidth. Similarly when we tune across it with a receiver, we can see it on the S-meter for quite a distance across the dial. There's quite definitely a bandwidth involved in what we see – but it's not the bandwidth of the carrier we're examining. What we see is the bandwidth of the spectrum analyzer or the receiver, as traced out for us by the almost-zero-bandwidth carrier.

When we looked a some of the implications of Q in our preceding section, we noted in passing that Q determines selectivity of a tuned circuit – and selectivity is just another term for bandwidth. The higher the Q of a circuit, the narrower its bandwidth. Also, the higher the Q, the less the loss in the circuit.

When we trace out the bandwidth of any measuring device by sweeping it across a carrier, we can tell nothing about the bandwidth of the carrier from that. The only way we could hope to actually measure the bandwidth of any carrier would be to have a test instrument with *less* bandwidth than the carrier.

We can attempt to get this, by increasing the Q and therefore the selectivity of the tuned circuits in our receiver or spectrum analyzer. As we do so, we increase the ratio of energy stored to that lost. Less and less driving energy is needed to produce the same amount of circulating energy within the circuit.

As Q climbs, somewhere along the line we'll reach the point at which the circuit "rings" so badly that we can't tell whether there's a signal coming through or not. This is because the Q is so high that any injection of energy takes a very long time to fade back down.

If we increase Q just a little more, we'll find that our selective amplifier is behaving more and more like an oscillator – so we increase our shielding and take all possible steps to prevent feedback.

But as we keep it up, we will eventually come to a point at which the Q is essentially infinite; any energy getting into the circuit just stays there circulating forever.

As we kept increasing the Q, the bandwidth got ever narrower. When we reached the point of practically infinite Q, our bandwidth was essentially as wide as a mathematical line; that is, zero. Now we have the device which has sufficiently narrow bandwidth to attempt to examine a carrier.

Unfortunately, we can't use it to examine anything. It has turned itself into an oscillator and is generating a carrier of its own!

Why Do Signals Require Bandwidth? Now that we've taken a look at the reasons why a carrier – or any single-frequency signal that is always on and never changes frequency – has no bandwidth, let's turn to the other extreme and try to find out why practical signals require *more* than zero bandwidth. It's just as confusing a question as was that of the carrier's lack of bandwidth.

In fact, many areas of communications (and not just communications by radio) involve a confusion between ideal theory and best achievable practice. So long as we keep firmly in our minds the notion that a theory is just that, and practice is something else again, we may be able to avoid some of the confusion. Most "authorities" lose sight of the separation between theory and practice, and then attempt to "simplify" the resulting confusion by putting in all kinds of assumptions. The inevitable result of this approach is increased confusion. We're often guilty of oversimplifying things – but we try to warn you when we do so.

About 21 years ago, a graduate student published a paper entitled "A Mathematical Theory of Information." In it, he drew a number of rather amazing comparisons between identifiable relationships in the practice of communications, and other relationships in the field of physics. Because of these comparisons, he showed how it was possible to fit the mathematical models developed by and for physicists onto the problems faced by communications engineers, and the result was the foundation of what we now call Information Theory.

Claude Shannon's original work has had astonishing consequences in the two decades

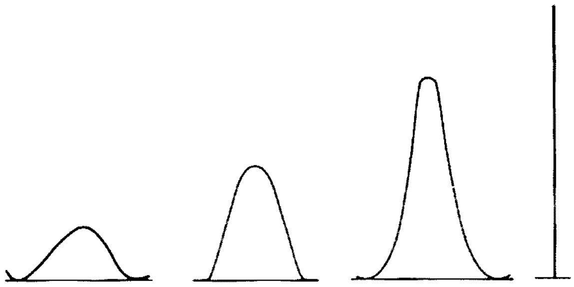

Fig. 5. Relationship between tuned-circuit Q, bandwidth, and impedance is shown in this sequence. Low-Q circuit has wider bandwidth and lower impedance than does medium-Q circuit. As Q is increased, impedance rises and bandwidth decreases. If means can be found to decrease circuit's losses, Q can be increased indefinitely—but at some point in this process the Q will be so close to infinite that no one can tell the difference. When this occurs, the bandwidth is unmeasurably close to zero and the impedance is also near-infinite. Any circuit we can build to do this will keep going indefinitely when a single noise pulse happens to ring the tuned circuit—and so we call it an oscillator.

since his original paper. Information Theory is now a recognized specialty of science, and has a jargon and a mathematics all its own. While almost all of it is applicable to our problems in radio communications, we won't try to go very deeply into it here at this time.

But we must examine the most basic part of it. The keystone to Shannon's whole theory was his establishment of a unit for measuring "information." He concluded that the least possible amount of information which could be sent anywhere about anything would be a single true-or-false statement, on the order of "does the object exist, yes or no?" Such a statement can be represented electrically by the presence or absence of a voltage on a wire, or by the presence or absence of an *rf* carrier.

Mathematically, a number system which has only two possible conditions is a "binary" or two-valued system, and each of the combinations is one binary digit. Shannon contracted the name "binary digit" into the abbreviation "bit" – and it's now the standard unit for measuring information.

In the International Morse Code, for instance, each character contains a specific number of bits – although in this code, the number of bits varies from character to character. The teletype code offers a much better example; it's standardized at seven elements per character. Of these seven, one is a start pulse and one is a stop pulse,

leaving the other five free to vary from character to character. The code is thus a 7-bit code, but contains only 5 bits of information per character while the other 2 bits are used to identify the start and stop of the character.

Shannon extended the bit concept to cover *all* transmissions of information. Even a SSB round table can be described in terms of the number of bits involved, using the mathematics of Information Theory. We don't need to go quite this far, any more than we need to know how many electrons must pass a point in one second to produce a current of one ampere in order to use an ammeter.

Because Shannon went on, having defined the bit as the basic unit of information, to formulate a law which relates bandwidth of an information transmission and bits transmitted per unit of time just as the ammeter relates current flow to electrons passing per unit of time. You might say he gave us an "informationmeter."

The law is simple enough. To transmit information at the rate of "n" bits per second requires a bandwidth of two times "n" cycles per second. To mark the start and finish of each bit requires that the signal be first turned on, then turned off; a cycle is defined as one full swing between on and off. Within a single cycle, it's not possible to tell whether the bit is on or off; within two cycles, though, you can determine whether both cycles are the same (bit on) or whether one differs from the other (bit off).

Once the relationship "frequency = twice bits" is set up, it's an easy mathematical operation to move it around and find out that "bits = half frequency." This is our "informationmeter." If we're using a bandwidth of 3000 hz for our voice transmissions, we're able to send no more than 1500 bits of information per second. Note that this rule doesn't say we're actually sending that many – it just says that we can't send information any faster than that within the 3 khz bandwidth. If we want to send information more rapidly, we must use wider bands; if we must conserve bandwidth, we'll have to slow down the information rate.

This also implies that *any* transfer of information requires at least some bandwidth. Our zero-bandwidth carrier conveys no information (except possibly the fact of its own existence, and that's nothing new after it has once been established). If we turn it on or off we can use it to send

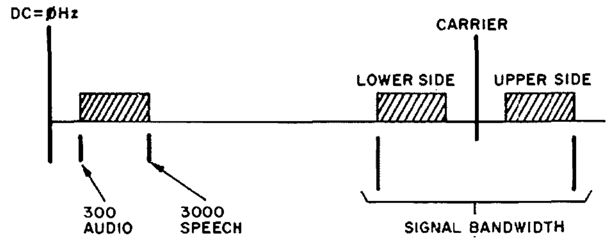

Fig. 6. Conventional AM translates audio signal such as 300-3000 hz speech shown here, up into rf spectrum as a pair of sidebands surrounding the rf carrier. Bandwidth of the composite signal then is equal to two times the highest frequency of the original audio signal because the lowest frequency in the composite is equal to carrier frequency minus the highest audio; and the highest frequency of the composite is equal to the carrier plus the highest audio. SSB signals eliminate the carrier and one of the sidebands, to provide a composite rf signal of only half as great bandwidth. DSB signals take as much bandwidth as conventional AM, but have no carrier.

information, but the mere act of turning it on or off introduces bandwidth.

About this point is where the confusion between theory and practice begins to become acute. It's not too hard to see how theory and practice fit together when we're talking about am voice signals, since it's obvious to our ears that voices have a mixture of frequencies and it makes fair sense to assume that the whole mixture is somehow made a part of the signal, in which case it's only natural to assume that the mixture must occupy more space than would a carrier alone.

But when we come to examine the bandwidth implications of merely turning a carrier on or off, or extend them into a study of the bandwidth required for a slow CW signal as compared to a fast one, it's a little harder to see.

Let's first see just how the voice signal comes to have a bandwidth, then work from there to see if we can find some similarities between voice and CW (no matter how ridiculous that may sound at this stage).

The human voice may contain frequency components as low as 50 hz and as high as 10,000 hz, but communications engineers determined by experiment about 1940 that recognizable and identifiable speech could be heard if the frequency range were limited to those components between 300 hz at the low end and 3000 hz at the high end. This, it must be emphasized, is *not* theory. It was the result of tests upon literally thousands of tourists during the 1940 New York World's Fair. Later tests have shown that an even

smaller frequency range can be used at some sacrifice in the identifiability of the speaker. Common practice today, however, uses the 300-3000 hz limits as the accepted range required for "communications quality" speech.

This pair of frequency limits, one upper and one lower, define a bandwidth of 3000 – 300 or 2700 hz as that accepted for communications quality speech transmission.

Any form of voice transmission, whether by telephone or radio, must transmit the whole bandwidth in order to meet the requirements of "communications quality transmission." If we're transmitting by wire, we simply convert the sound to its ac electrical equivalent, transmit the resulting electrical signal over the wire, and reconvert it to sound at the other end.

If we're using radio, we must be a little different. Audio-frequency energy isn't convenient for direct transmission, so we convert the *af* signal up to the *rf* region, radiate it to the receiver, and there convert it back to an *af* electrical signal.

With conventional AM, our conversion from *af* to *rf* is rather direct; we simply offset the frequency by the desired amount. Since the "center frequency" of speech is zero rather than anywhere within the bandwidth of the signal, when we offset it up to the *rf* region we get not just one but two signals known as sidebands, either of which is a complete conversion of the original *af* signal. The carrier, between the two sidebands, corresponds to the zero center frequency of the original signal, and in the receiver it serves to allow the two sidebands to fold back into a single replica of the original signal, reproducing each of the original frequencies perfectly.

We can get SSB by eliminating the carrier and either of the sidebands, but at least one sideband must be transmitted.

If we choose to use FM, we use the original *af* signal to vary the frequency of the radiated *rf;* while it would appear that no exact replica of the original signal is transmitted in such a case, it can be shown mathematically (and demonstrated physically as well) that the original signal is present in the sidebands of the FM signal in such a way that it can be recovered from them without making use of the frequency variations. Normally, of course, our FM receivers do make use of the frequency variations.

When we use FM, we "encode" the original *af* in the frequency variations of the transmitted signal. This means, in practice, that we must occupy more bandwidth with the FM signal than is necessary to transmit the signal by AM; in Shannon's terms, we must transmit more information when we use FM.

But no matter which of these techniques we use, we must transmit the full original bandwidth of the signal – and that's our major point now.

While we're looking at modulation is a good time to dispose of one of the more confusing practical points introduced by authority's attempts to "simplify" – that's the notion that "carrier shift" in a modulated signal indicates some malfunction.

"Carrier shift" is a change in the strength of the carrier when modulation is applied, and the general belief is that the carrier's strength always remains constant during amplitude modulation, with only the sidebands changing in amplitude.

This general belief is true – if you're transmitting only a pure sine wave as

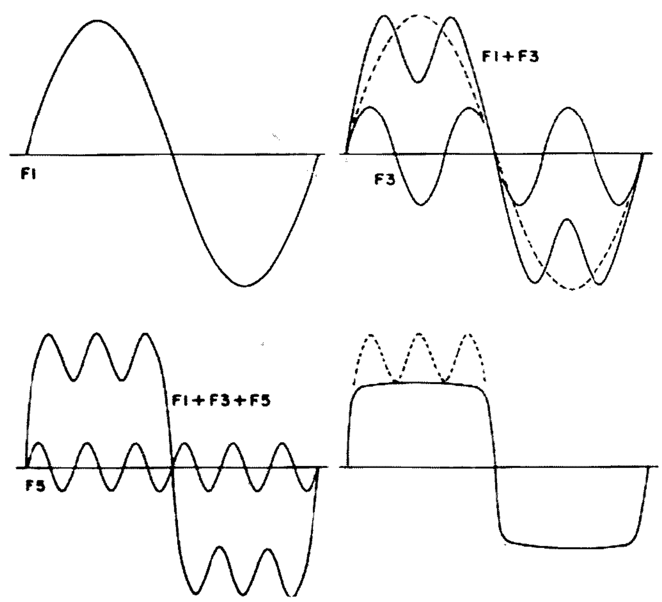

Fig. 7. Square wave signal (lower right) can be built up from sine waves when they have the proper frequency and phase relationships to each other. Start with a sine wave of the same frequency as the final square wave (upper left). Add to it another of three times the frequency but "in phase" with it; this sharpens the sides and flattens the top (upper right). Add to the resulting signal another sine wave of five times the original frequency still in phase, which flattens out the top of the waveform still more (lower left). Clipping off the top and bottom of this waveform produces a "square" wave with some slope on the sides.

modulation. If you're transmitting speech, though, or any other signal which has more of its energy on one side of the zero line than the other, then carrier shift *must* occur in a properly operating modulator! The reason for the confusion is that almost all explanations of modulation action are based on the "simplification" that only sine waves are to be used as modulating signals; in practice, of course, sine-wave modulation is hardly ever encountered.

In TV transmission, carrier shift is necessary in order to convey the average brightness level of the scene being transmitted. This offers an excellent example of the discrepancies between most theoretical explanations based on simplifications, and the conditions actually met in practice.

But it doesn't tell us much about the reasons why CW signals require bandwidth, when all they amount to is the turning on or off of a zero-bandwidth carrier.

To tackle this particular bag of worms, let's begin by forgetting all about CW signals, and both voice and sine-wave modulation too for a little while. Let's look instead at the interesting case of a square-wave modulating signal.

The theoreticians tell us – and we have no particular reasons to doubt them – that an ideally square-cornered square wave requires an infinitely large bandwidth. This comes about because getting those perfectly square corners on the waveform requires an abrupt change in signal to occur in literally zero time. We won't worry about that, because we're going to round off the corners of our "square" wave a little bit right here at the start. In fact, we'll round them off more than just a little bit. What we'll do is round them off enough so that we can generate the same waveshape by taking five sine waves of particular frequencies and phases and mixing them together, as shown in the illustration.

Once we've done this, we will be fairly safe in assuming that it will take as much bandwidth to transmit either the rounded-off "square" wave itself, or the combination of the five sine-waves. We can easily calculate the bandwidth requirement of the five sine-waves by simply subtracting the lowest frequency from the highest. The square wave, then, must require at least as much.

Since we want a squared-off flat top on our wave, and the mixture of sine waves has some ripple along its upper edge, we must also permit the square wave to contain a dc component. This means that its required bandwidth must extend from zero to dc at the lower limit, up to that of the highest-frequency sine wave at the upper limit. In other words, if the repetition rate of the square wave we have shown is "n" cycles per second, then it will require a bandwidth of "5n" hz for transmission.

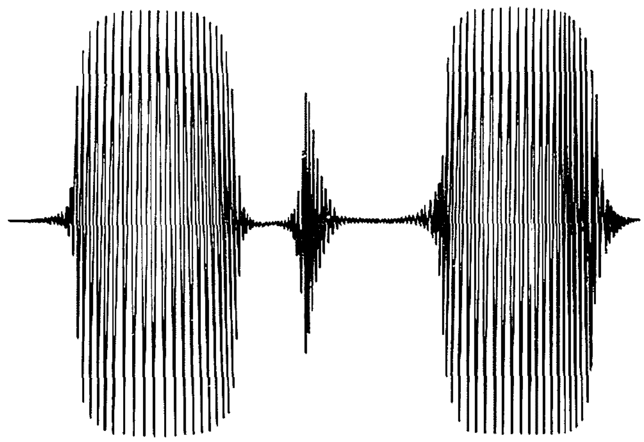

Fig. 8. If we modualte an AM transmitter 100% with the signal we developed in Fig. 7, the output waveform will look like that at the above left. If, on the other hand, we key a CW signal and have the proper shaping circuits to prevent key clicks, we'll get an rf output from the transmitter as shown at right. Essential identity of these two waveforms shows that CW may be considered as a special case of AM, using a "square" wave modulating signal instead of speech or tones.

Now let's take our modified square wave and feed it into a modulator connected to an ordinary AM transmitter. At low modulation levels we get something not too different from speech; but if we keep cranking up the gain until we reach the point of 100% modulation, so that the signal is completely cut off during the "down" portion of the square wave and is at full amplitude during the "on" portion, the transmitter's output is difficult to distinguish from CW.

Yet we have determined that the square wave shown requires a bandwidth of five times its repetition rate for transmission, and we know that any conventional AM transmitter must produce a signal with a bandwidth at least equal to that of its modulating signal. This means that our transmitter's output must occupy a bandwidth at least five times the repetition rate of our "square" wave.

We can show that the output of a CW transmitter being keyed at the same speed, with the keying waveform shaped to exhibit the same "make" and "break" rounding, must occupy the same bandwidth in the same way that we built up the "square"

wave from five separate sine waves; things which are indistinguishable from each other are equivalent to each other, and in order to be indistinguishable each must have *all* the characteristics of the other.

Since the bandwidth is related to the repetition rate of the modulating or keying signal, it follows naturally that the greater the keying speed, the more bandwidth is required. The conversion factors to get from keying speed for repeated "dits" over to a transmission speed in words per minute are numerous – and many of them involve statistical averages and approximations, such as the average number of bits in any random code character. The working factor most usually used is that the bandwidth required (in cycles per second) is equal to four times the keying speed in words per minute. A 10 WPM transmission, then, would require only a 40-hz bandwidth, while to transmit CW at 100 WPM the signal must occupy 400 hz.

When the FCC – or any other governmental agency – talks about signal characteristics, they usually use the CCIR emission-type code to designate the type of signal they mean. This is a combination which always includes a capital letter, followed by a single numeric digit, and may be preceded by another number. The letter designates the general class of modulation applied to the signal; A stands for "amplitude," F for "frequency", and P for "pulse." The digit following the letter indicates just what type of modulation ia applied; Ø indicates the absence of any modulation intended to carry information, 1 indicates telegraphy with no superimposed audio, 2 indicates telegraphy making use of audio modulation accompanying the carrier, 3 indicates telephony, 4 indicates facsimile, 5 indicates television, and 9 indicates composites of the above and miscellaneous types.

If a number precedes the letter, that number indicates the signal's bandwidth in khz.

For example, A1 indicates that amplitude modulation of telegraphy without accompanying audio is involved. This is the classic CW case. If raw ac were applied to the transmitter plates so that the signal were audio-modulated by the 60-hz hum, it would be A2. A3 is any type of amplitude-modulated telephony, including SSB and DSB. A5 is amplitude-modulated television. AØ would be a steady carrier, so would FØ or PØ, for that matter.

The FSK signal used in most RTTY work is type F1; AFSK used at vhf, is F2. FM voice communications are F3.

Indication of bandwidth produces such codes as "6A3", which is 6-khz bandwidth AM telephony; "6000A5,F3", which is commercial TV including its FM audio channel, and "0.1A1", which is 25-WPM CW (which takes 100-hz bandwidth).

In addition to the three elements of this code we've discussed, lower-case letter suffixes may be used in some cases. SSB is indicated as "3A3a," in which the "a" indicates single-sideband reduced carrier transmission. If two independent sidebands are transmitted, the code would be "6A3b"; this type of transmission is used only in military and commercial work, and is known as "independent sideband" modulation. The different types of pulse modulation, similarly, are denoted by "d" for PAM, "e" for PWM, and "f" for PPM.

By decoding the capital letter and following numeral to determine what type of signal is being discussed, you can then supply the appropriate bandwidth. Bandwidth for an A1 signal depends upon the keying speed, but will be approximately 4 times the WPM of the keying. Normal AM voice requires 6 khz (6A3), as does DSB, but SSB takes only half as much space since only one sideband is used. With FM, the adjective "narrowband" is often used but it has very little meaning. In commercial FM broadcasting, any bandwidth less than 150 khz is "narrow", and in commercial two-way work "narrowband" means anything under 25 khz. In ham use, though, it usually means a bandwidth not greater than that required to transmit the same signal be conventional AM; for voice, this would be 6 khz. F3 transmission on the 3-through-30 mhz bands is illegal unless its bandwidth is restricted to this figure or less.

Why Is It Mandatory That A Mixer Be Non-Linear? One of the master keys to modern radio is the principle of "mixing" or frequency conversion, which permits us to change a signal from one frequency to another without changing the modulation it carries -- and, for that matter, permits us to modulate it in the first place!

All authorities agree that a mixing device must be non-linear, and that any non-linear device can be used to mix signals – but the reasons why non-linearity and mixing go hand in hand are seldom examined with any degree of clarity.

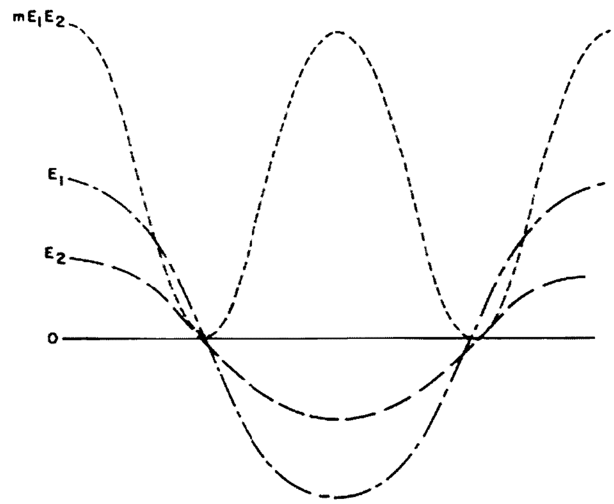

Fig. 9. Mixer action is shown here. Dotted waveform is the output signal of sample circuit, produced by multiplying two input signals E1 and E2. This plot, traced from one produced by a digital computer, extends over only one cycle and so does not show envelope variations described in text. It does, however, show how multiplication of two sine-wave signals produces a third signal which is the sum of the two original signals.

About the only studies of it to be found in print look at the whole question mathematically – and require some knowledge of the integral calculus! Let's see if we can make this a little easier to get a handle on, with an absolute minimum of mathematics.

The one bit of math which we can't escape is the idea that an amplifier has the effect of "multiplying" the amplitude of its input signal.

That is, for an input of "x" volts the output will be "gain times x" volts, if the amplifier is operating in a completely linear manner.

This assumes, of course, that the gain is constant – and that defines for us any "linear device." A linear device is any device in which the output signal is equal to the input signal multiplied by some constant factor.

A resistive voltage divider composed of two 1000-ohm resistors in series is a linear device, for instance, because its output is always equal to half the input signal. The "half" is the constant.

But if the constant in a linear device is truly constant (which it must be, by definition), then every output signal from the device must have come into it as an input signal identical to the output in every characteristic except amplitude, and with amplitude equal to output amplitude divided by the constant.

This means that if we apply a 1-volt 60-hz signal to a linear device with a gain constant of 10, and at the same time apply a 10-volt 6-khz signal, out output can consist only of a 10-volt 60-hz signal and a 100-volt 6-khz signal. No interaction between input signals can possibly occur in a linear device, because if it does then the device *by definition* is not linear!

Now let's assume we have an amplifier with two sets of input terminals on it. For one set of input terminals, the amplifier is linear; any signal fed in here appears as an exact duplicate (only larger) at the output. The other set of terminals, however, provides gain control for the amplifier. Any signal applied to this set doesn't show up in the output; instead, it causes the gain of the linear part to change.

This is an approximate description of the action of an AVC-controlled receiver *if* amplifier stage; it acts as a more-or-less linear amplifier for the signal path, but its gain is controlled by a dc signal applied to the AVC input terminal.

Just to try to keep things simple, since we're talking about a theoretical amplifier anyway rather than any actual circuit, let's assume that the gain-control terminals are "linear" too. That is, if the voltage at the gain terminals is 2 volts, gain is 10 (let's say), and if we raise the voltage to 4 volts the gain through the linear section rises to 20. Cutting gain voltage back to 1 volt, though, reduces gain to 5. The "constant" for this action is simply that the gain of the linear section is five times the voltage applied to the gain-control section.

If we apply steady dc to the gain-control section of this circuit, we will have a linear amplifier from signal input to output. A 1-volt 60-hz signal going in will produce only a 60-hz signal out, at a voltage level five times that of the dc applied to the gain-control section.

But what happens if we apply ac on top of the dc at the gain control terminals? Let's assume that we're putting 4 volts of dc in, with 1 volt of 10-hz square-wave ac superimposed on it. That means that for 1/10 second, the dc level at the gain control terminal is only 3 volts, and for the next 1/10 second the dc level will be 5 volts.

With our 1-volt 60-hz signal going into the signal input, our output now consists of 1/10 second of 3-volt 60-hz followed by 1/10 second of 5-volt 60-hz. The ac signal fed into the gain control terminal has varied the gain through the signal channel, and has introduced itself into the output signal by so doing.

Notice especially that the output consists of the original 60-hz input signal, *controlled by* the 10-hz control signal. Had we simply applied the 60-hz and the 10-hz signals to the same input of a completely linear device, they would have both appeared in the output but each would have been completely independent of the other. Had we used a linear amplifier with a gain of 10, for instance, the 60-hz signal would have had a peak-to-peak value of 10 volts at all times regardless of the level of the 10-hz signal. In our special circuit, the amplitude of the 60-hz signal is determined directly by the amplitude of the 10-hz signal.

We can make it a little clearer by using just a trace of math at this stage. We defined a linear amplifier as one which produced an output exactly equal to gain times input. If we represent the "gain" constant by the symbol "k," the equation defining linear amplification is: $E_o = k \times E_i$.

The equation defining action of our special circuit is very similar, but instead of "k" we must put in a term which relates gain to control-input voltage. Let's call the "signal" voltage E_1 and the gain control-input voltage E_2, and use the symbol "m" for the constant which relates circuit gain to control input voltage. Circuit gain then can be expressed as "$m \times E_2$", and the defining equation for output voltage becomes: $E_o = (m \times E_2) \times E_1$, which we can simplify to $E_0 = mE_1E_2$.

The big difference, since both "m" and "k" are constants, is that in a linear circuit the output depends *only* upon the input, while in our special circuit the output is the product of two input signals multiplied together.

The special circuit, incidentally, cannot be linear except under the special circumstances we picked to introduce it. If varying signals are applied to both inputs, the gain is not constant and therefore the circuit cannot meet the requirements of the definition of a linear device.

At this point we have determined that we have at least one non-linear circuit, and we have found that its output signal is the product of its two different input signals. We have not yet, however, proved that the circuit satisfies the definition of a "mixer" by producing in its output both the sum and difference frequencies as well as the original frequencies of both signals – although we have seen how both original frequencies are

present, and we have also seen that they are inextricably mixed together.

It's fairly easy to see how a difference frequency is developed if we stick with the same circuit but try some new signals. Let's put a 1000-hz sine-wave signal in at the input E_1, and a 1010-hz sine-wave in at E_2. We'll begin our examination of the action at some point when both input signals are at their peak value at the same time. This means that the output signal will also be at its highest possible value for these input signals since it is thy product of the two multiplied together.

Now let's let one full cycle of E_1 go by so that it is again at its peak value; this will take 1/1000 second. In that same 1/1000 second, E_2 will go through a little more than on full cycle (1.01 cycle, to be exact) and will be at a voltage a little lower than its peak value. This will cause the level of the output signal to be a little lower than it was at the previous E_1 peak.

Another cycle of E1 later, E2 will have gone even farther and the output will be lower still. Every cycle of E_1, E_2 will have gained 1/100 cycle and so the output will always be changing at a rate 100 times slower than E_1. When 50 cycles of E_1 have elapsed, though, E_2 will have gained exactly half a cycle and will be at its *negative* peak; for the next 50 cycles of E_1, the value of E_2 will be climbing back, and exactly 100 cycles of E_1 after our initial point, both signals will be at their peak value simultaneously again.

The envelope of the output signal, therefore, must be varying periodically at a rate 100 times slower than E_1, or 10 hz. This variation of the output signal envelope *is* the difference-frequency component; if we feed the output through a resonant circuit tuned to this frequency, the higher-frequency components will all be shunted out but the variation at this frequency will drive the resonant circuit.

Generation of the sum frequency is similar, but does not involve the output-signal envelope as such. Instead, the sum frequency component comes from considering the positive half-cycles of the output signal as being driving pulses in themselves. During any one-second period, E_1 will contribute 1000 positive half-cycles, and E_2 will contribute 1010 of them. The output circuit, then, contains potential driving pulses for a resonant circuit which occur at the rate of 2010 per second. Even through the few times when the peaks of both input signals coincide (and therefore contribute only one driving pulse instead of two), the statistical average frequency is still the sum of the two input frequencies because it's picked up by a tuned circuit and the flywheel effect of the resonant circuit smooths out any occasional miss in the driving source.

Since we've scored the "authorities" so heavily for their attempts at oversimplification, it's only fair to point out that this description of mixer action is in itself highly oversimplified in order to escape the cumbersome mathematics usually employed. Among our simplifications were the assumption that a perfectly linear circuit might possibly exist, the statement that it was possible in our sample circuit to vary gain in a linear manner so that the output was exactly equal to the product of the two input signals (this is ideal mixer action, not practical action), and the use of signals of approximately the same strength for mixing together.

The statement that mixing occurs by gain variation was only a partially correct one; most practical mixers operate by gain variation but it's not completely necessary, sincc a few work by switching action.

In most practical mixing circuits, the non-linearities involved are considerably more complex than those we have examined here. The gain of any actual amplifier must have some curvature in it over any wide range of input voltages. This curvature provides the "non-linearity" usually used for mixing. In most mixers, the mixing action is achieved by selecting the operating conditions so that the curvature effectively squares the input signal; this is called "square-law" action.

The signals we're dealing with are most usually sine waves, and when several sine waves are all squared at the same time, the production of sum and difference components follows automatically in any mathematical description of the circuit. The actual process, though, may be more like the picture we've presented here than it is like mathematics; no one knows for sure, but math is a tool for describing things – not a necessary reason for their existence! No mathematical equation ever forced a physical event to happen, although it may have permitted us to forecast the event's occurrence.

Staff

Switch Controlled VOX Delay

The SB-400, and many other rigs, have semi break-in CW which is just fine when calling DX stations and then listening for your call to come back—or when passing traffic and listening for a break from the receiving station. It is, however, a distinct disadvantage when you wish to chat with a fellow on CW. The make and break of the exciter and antenna change-over relays between each letter and sometimes between characters of a letter can drive you to AM, not to mention the wear and tear on your nerves and the relays themselves. I am now on my third Dow-Key relay, and they aren't cheap.

The solution: Add extra capacitance in parallel with the .05 μf capacitor C123 at V12B—the relay amplifier. I found that .2 μf of capacitance between pin 7 of V12B and ground—controlled by a foot switch (Linemaster 491-S or similar), gave me a two second delay before the relays dropped out. This gives me plenty of time to collect my thoughts and still continue sending in peace and quiet. A .3 μf capacitor will give 2½-3 seconds of delay, if needed.

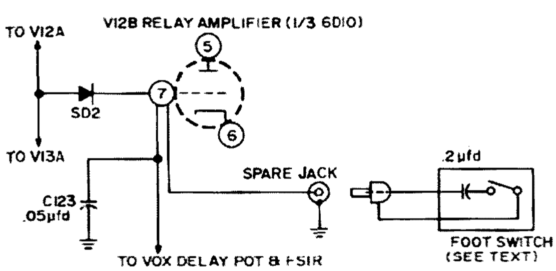

Fig. 1. Foot switch control for VOX delay.

The particular foot switch used here allowed plenty of room inside to mount the capacitor, and a zip cord was run from the switch to one of the spare jacks on the rear of the 400.

When you want the extra delay, just press down on the foot switch. Releasing it will instantly bring back the original vox delay time as set by the internal control.

Gerry Offenberg, WB2HXD

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Big Signal – Good Looks

You can build a good performing, professional appearing linear amplifier. You don't have to be an electronics engineer either. Building and operating your own equipment is a highly enjoyable part of ham radio, and careful workmanship will produce a unit you can operate and show with great pride.

Having compromised my antenna for the sake of neighborhood relations, my T-4X wouldn't reach out as I wanted. More power seemed to be the only answer: A linear amplifier.

Here is how I reached my goal, not a step-by-step construction article, but a description of what I did and at least some of the "whys." One of the first decisions I made was to select a tube. The 3-400Z offered a lot of advantages, and I had a power transformer to suit it.

The power supply is on a separate chassis with the space shared about equally by the transformer and the series bank of filter capacitors. Other essentials are tucked in corners here and there. A perforated aluminum cover was made for the top, and there is a heavy plate on the bottom. Interlocks were included to help reduce the likelihood of electrical shock. The meter on the panel also helps, because it indicates how much charge is still on the capacitors. Regulation is fair. The voltage is 3,000 at 100 ma; SSB peaks cause it to drop to about 2,800 volts. At 400 ma the voltage is 2,500. The high voltage is supplied to the amplifier through a piece of RG-8/U. All other leads to the amplifier are in a common shielded cable terminated in an octal plug.

The amplifier circuit is quite straight forward. A few changes were made to fit the components on hand, of course, just as you will want to do. Also, some extra pains were taken to bypass power and control circuits leaving the amplifier so as to concentrate the *rf* in the antenna circuit.

Local Eimac engineers talked me into buying their air system socket, because they have seen so many tubes which have been damaged in some of the more rigid ceramic sockets. The 3-400Z can be biased to a very low standby plate current, but Eimac states emphatically that this tube is designed so that the plate is a "getter," and it should run hot. If the tube idles with the filament burning and very little plate current flowing, there is a strong possibility that the tube will be "poisoned." Of course it does take a little while to get used to seeing a tube on "standby" with a red-hot plate!

The power switches on the amplifier are wired uniquely. Only SPST switches are needed, but I had DPST types on hand and I couldn't let those extra contacts go to waste. No matter which switch is operated first, the filament, only, is turned on. The second switch to be operated turns on the high voltage. If the second switch on the amplifier is not turned on, keying the exciter will not operate the antenna change-over relay,

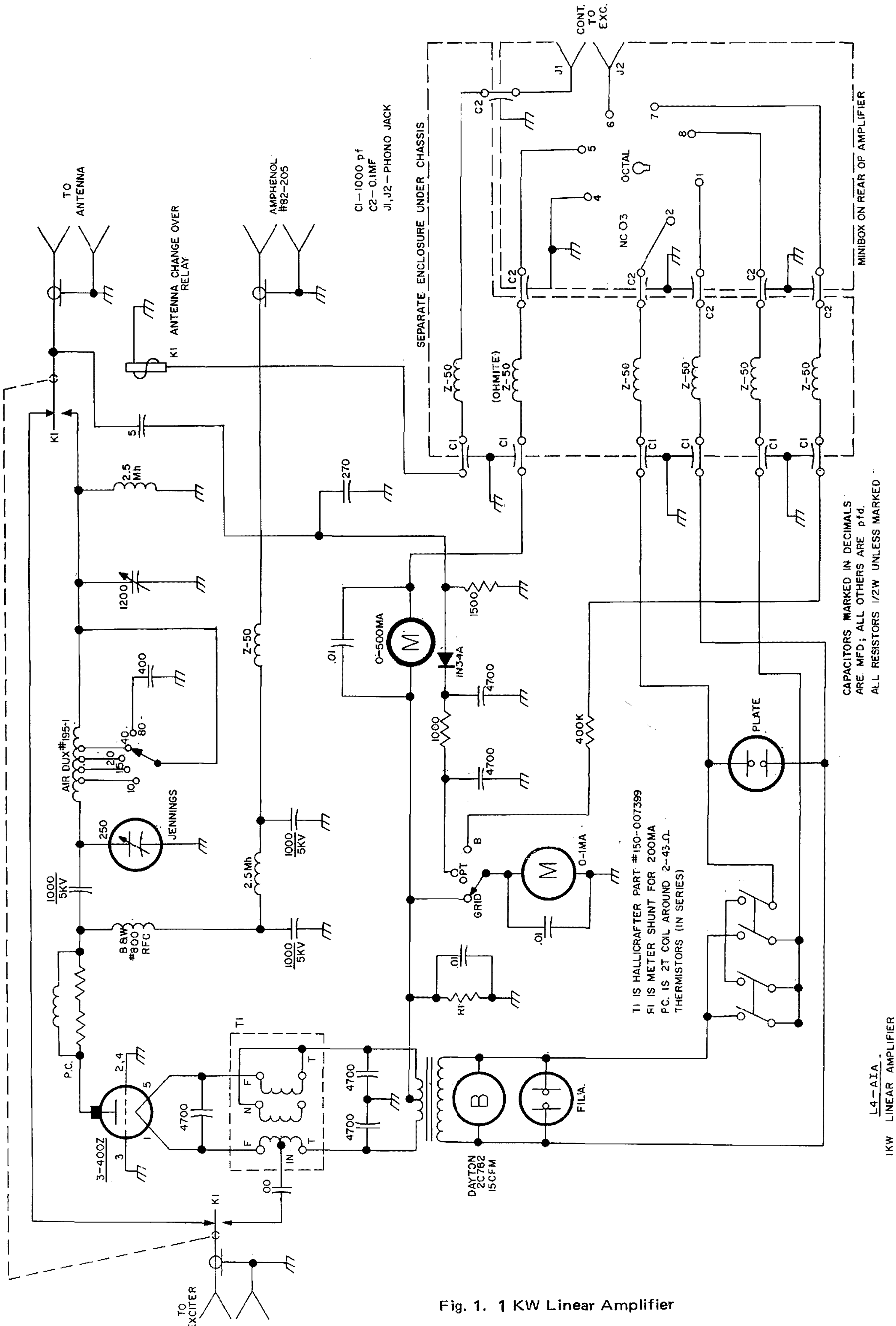


Fig. 1. 1 KW Linear Amplifier

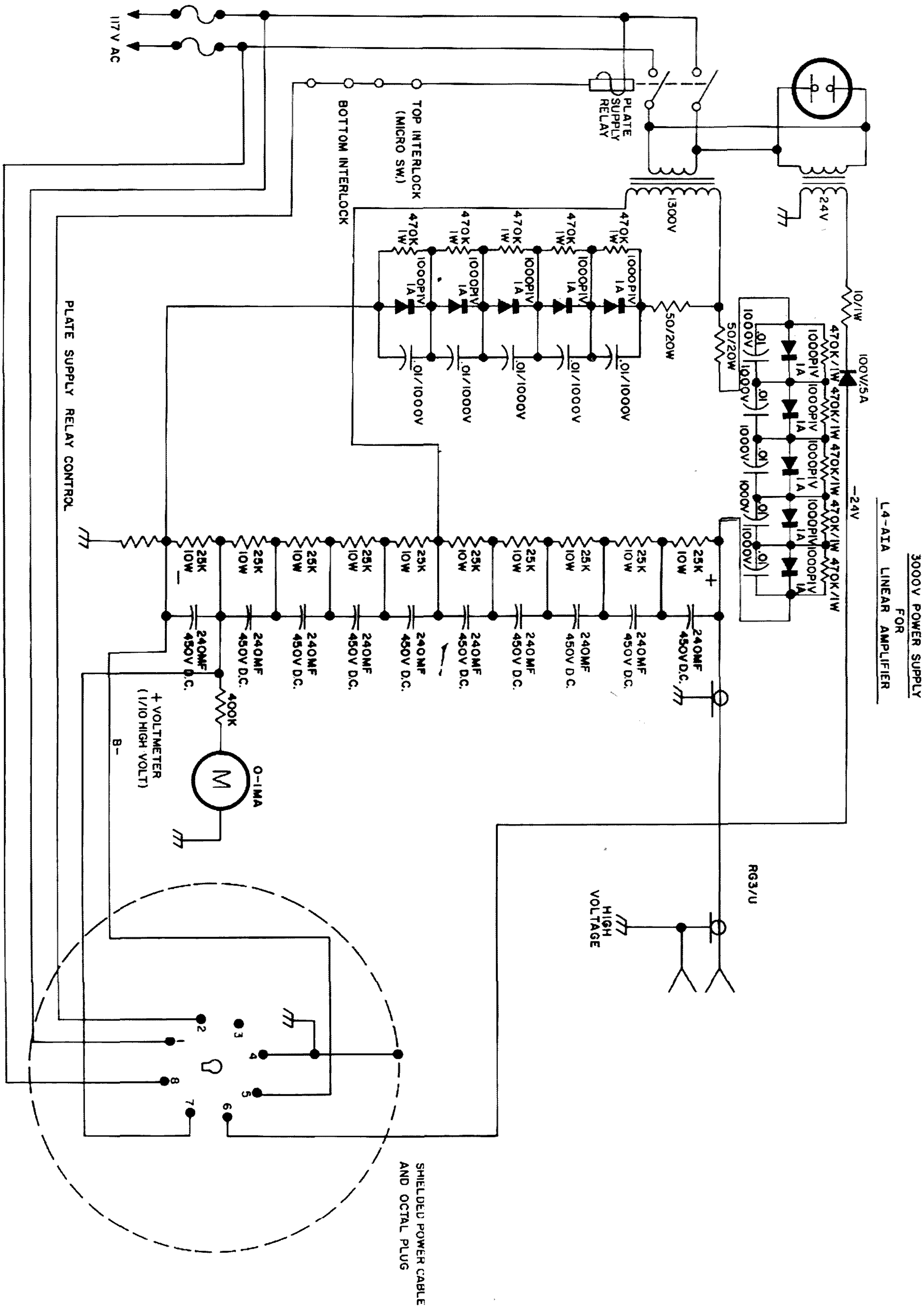
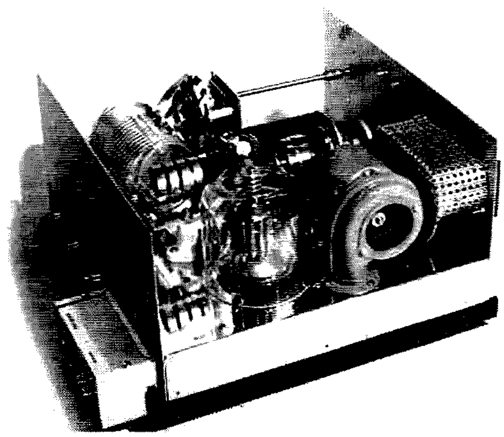


Fig. 2. 3000 volt power supply for 1 KW linear amplifier.

and the exciter will be connected to the antenna. If the high voltage supply is turned on, power will be supplied to the antenna change-over relay whenever the exciter is keyed, and the relay will connect the exciter to the amplifier input and the antenna to the amplifier output.

The pilot lamps (Olson Electronics) have large red lenses on which the lettering was applied. NE-51H are used in them with a 33k series resistor. This is a lower value than is specified for the lamps, but it doesn't seem to affect their life very much.

Several commercial amplifiers use only one meter on the panel, but I wanted to be able to monitor the grid and plate current simultaneously. The grid current meter (1 ma movement) can be switched to monitor relative power output or B+. In fact, it is connected so that it can also be used to monitor the exciter output.



No space wasted here! Notice filterbox on rear panel.

The Z-50 *rf* chokes shown inside the dotted lines on the amplifier schematic are enclosed in a separate shielded compartment beneath the chassis. The feed-through capacitors, CI and C2, extend from this enclosure into, and out of the chassis, respectively. The screw terminals of the 0.1 feed-through capacitors (Sprague Hy-pass) are enclosed in a 2¼ x 2¼ x 5 inch Minibox on which the octal socket for the power plug is mounted. The phono jacks for the control leads to the exciter are also mounted on the Minibox. The control leads are also shielded as an additional precaution to avoid stray *rf*.

Most of the parts are rather common and few were purchased of a special nature. Due regard was paid to circuit requirements, but available components with suitable characteristics were used freely. The antenna change-over relay (in the corner beneath the tank coil) is a surplus unit with large contacts. I can note no significant increase in SWR because of it.

So much for components and circuitry; now for some comments about obtaining a commercial appearance. Before you drill a hole, make several trial layouts of your components. It is best to make your sketches to approximate scale. Crossruled paper (I use 4 squares to the inch) is very handy for this preliminary layout work. Measure everything very carefully; check clearances, and try different layouts before "freezing the design."

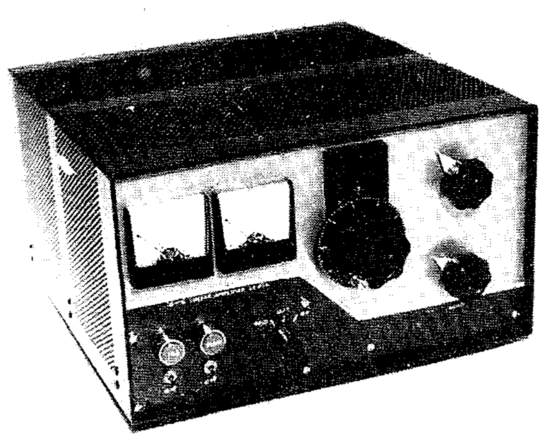
Commercial enclosures are available from several sources; I purchased one from the R. L. Drake Co. to match my exciter. The chassis and the front and rear panels were carefully designed to fit the enclosure. A local sheet metal shop helped me with some of the bending and shearing. Panels are aluminum; the chassis is sheet iron (ungalvanized). After all the holes were drilled in the chassis, and parts checked for fit, the chassis was copper plated. Some component mounting brackets were made of aluminum, and I finished them nicely and polished them before mounting the components. A few pieces of scrap lucite were used in both the power supply and the amplifier for supports or spacers.

The rear panel is not painted, but it is clean and smooth and all connectors have been labeled. After the front panel was completely drilled, and after all parts had been mounted a time or two to make sure everything would fit, it was ready to be finished before "final assembly."

First I polished it, and then I cleaned it with benzine to remove all traces of oil and grease. Then I carefully masked the lower part with masking tape and newspaper and sprayed the light color on the top part of the panel. The rule here is to spray *lightly:* thin

coats dry quickly and aren't so likely to sag. Spray paint cans work better when held nearly vertical, but panels are most apt to have runs if they are vertical. My solution is to spray quickly and lightly with the panel (and spray can) vertical, and then quickly lay the panel horizontal until it is ready for the next coat. Incidentally, I find that a "tack rag" is indispensable at this point. I carefully wipe the panel with it before each spray coat. (You can buy a "tack rag" at your paint store – or work varnish into a cloth and make your own. The commercial ones are not expensive and are much better than the ones I've made.) When you have enough coats on the top section, put it aside to dry well. It is best to remove the masking tape as soon as the last coat begins to dry; don't wait too long. After the top part was thoroughly dry I masked the painted part and proceeded to put the darker color on the bottom section of the panel.

After the paint is dry (wait 48 hours) the control markings and labels can be put on. *This is the time to take great care.* Sloppy panel markings will spoil the appearance of a good project every time. There are two easy ways to mark your panels: decals or "rub off" (dry transfer) lettering. I prefer the latter, but you can get either kind from your local supplier in black, white, or gold (Datak or Walsco). Use a color which will contrast well with the panel finish; do not mix colors. If I use decals, I always trim the background material right down to the letters. It isn't so conspicuous that way. After the decal is dry, I spray it with clear "Acry Spray" (Walsco). Be careful though! Use the spray very lightly or you may find you have sprayed your beautiful panel with a very effective paint remover! I found some automobile paint in touch-up spray cans that is acrylic so is not affected by the Acry Spray if you use it



Homemade . . . but it looks pro, doesn't it?

lightly. Be very careful with enamel though; it is touchy.

The dry transfer labels and markings look a little more professional, I think. Read the instructions carefully. I found that by rubbing very lightly you can get the results you want. After rubbing the letters, peel the plastic backing away slowly; if a part of a letter sticks to the plastic you can rub a little more. But if you rub too hard the plastic base will stretch, and you will have to start over. If that does happen, you can easily remove the unwanted letters. After burnishing according to the instructions I use the clear spray to seal them to the panel. Remember, spray lightly. My meter dials were originally marked "dc volts" and "dc milliamperes." I carefully removed those markings with a soft rubber eraser. I didn't touch the scales; I found meters with the graduations that I wanted. It is very hard to put on a new scale that looks professional. I put new labels on the meter scales with the dry transfer lettering, but didn't spray them. The new markings look as good as the factory job.

When assembling your project for the last time be very careful. A slip of the screwdriver can make a mighty big, unsightly scar. Route your wiring as neatly as the circuit will permit. Tie noncritical leads together in a cable. Although my technique will not be applicable to some projects, I used shielded wire in non-*rf* circuits and used strips of copper flashing material 3/8" wide for *rf* circuits.

Frequently it is convenient to make compression connections where some plastic material is included in the "sandwich." *Don't do it!* Sooner or later the plastic will change its dimensions enough to permit the connections to loosen. This will cause an intermittent or poor connection. If the connection carries much current it will start to heat up and things will rapidly get worse as the plastic "cold-flow" phenomenon accelerates as the temperature increases. I followed the tune-up procedure contained in the *Radio Amateur's Handbook.* I was very careful to give the high voltage all the respect that it deserves. How does my homebrew linear perform? I am pleased to report that during a recent contest I was able to work several new countries. How does it look? The illustrations speak for themselves. Why don't you plan now to have a top-performing, good-looking entry in that next homebrew contest? Now is the time to start!

. . . WA7A1A

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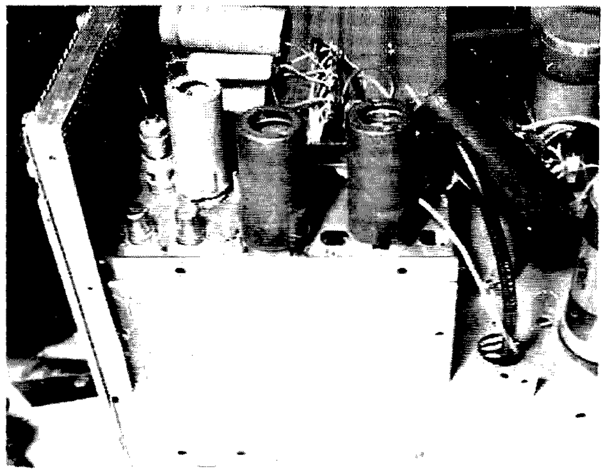
A New Vidicon Camera for ATV

In the last several years many articles have been published on vidicon cameras. Two of these articles are outstanding, number one appeared in the November, 1959, issue of *Radio Electronics.* This was entitled "T. V. Camera" by Derek Swaine of Sylvania Electric. The article discussed a closed circuit TV system. The second article appeared in the Denson Corporation's ATV booklet.

That now brings us to this article on a vidicon camera system. This system will be directly applicable to transmitting video on the air. The type of vidicon used in this camera is the 6326A.

By studying the block diagram you can see that there are quite a few modifications and additions to the existing closed-circuit TV systems.



View of video preamplifiers as they are located on the camera chassis.

Video Preamplifier

Referring to Fig. 1. it is noted that V1 and V2 (6CW4 nuvisters) are used as a

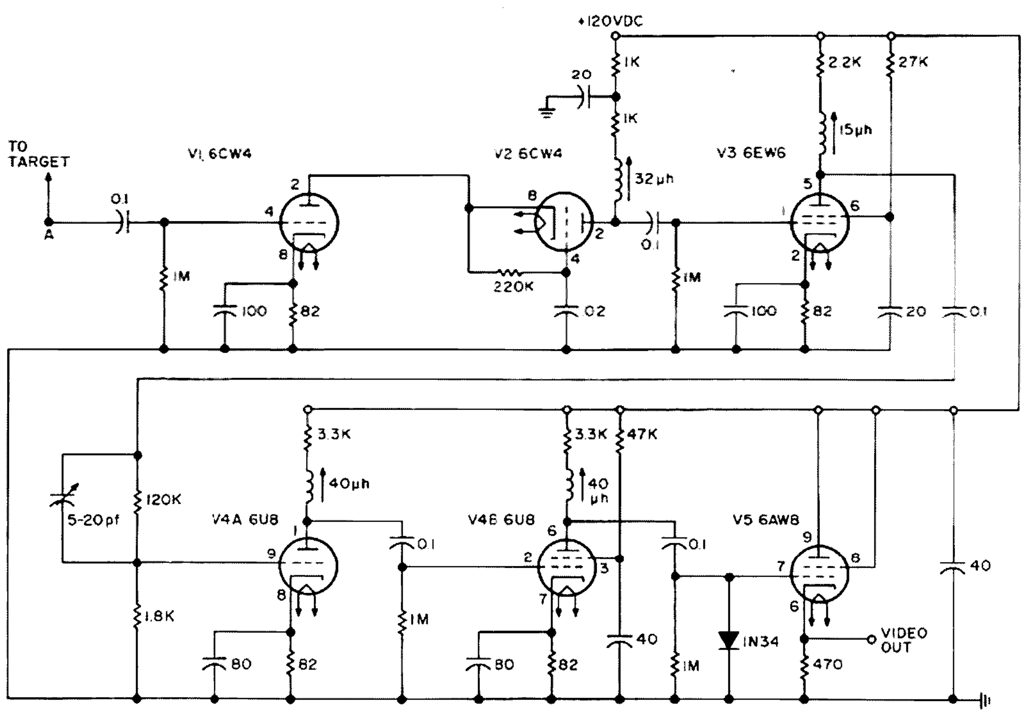
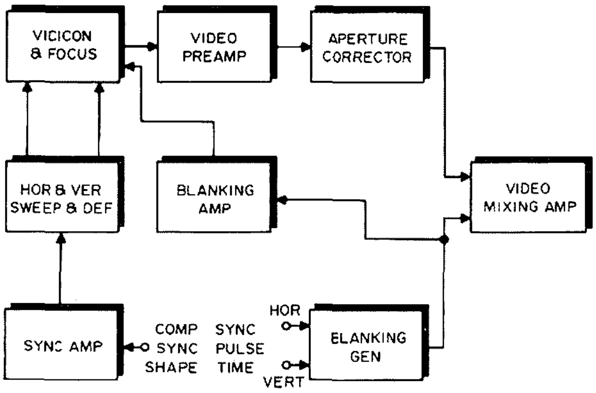


Fig. 1. Video preamplifier.



Block diagram.

cascode low noise input stage. V3 (6EW6) amplifies the video from the cascode stages. Stage V4A is the high peaker stage. V4B amplifies the peaked video to a usable level. V5 is the cathode follower output stage. The preamplifier is rather sensitive to closely located broadcast stations. Complete shielding and decoupling is a must in this case, particularly the B plus and filament leads to the video preamp.

The video preamp was redesigned for at least three reasons: (1) Higher frequency response; (2) More control on high peaking stage; (3) Improved noise figure.

Also notice that no blanking pulses have been inserted into the video preamp. This is added in the video mixing amplifiers.

Sweep and Deflection Amplifiers

Our next task was the redesign of the horizontal and vertical sweep oscillators, which is shown in **Fig. 2**. The purpose being for the sections to accept the standard RETMA sync pulses. Both of the horizontal and vertical oscillators are of the blocking oscillator types. The composite sync is fed to an integration and differential networks respectively. Locking action is very good.

No problems were experienced at this point. The pulse amplitudes and shapes are identical at the inputs to the deflection stages, as in the original camera units. The deflection amplifier's design was altered very little. A little difficulty was experienced with the centering controls, so that voltage dividing networks were altered. This modification is noted in the schematic.

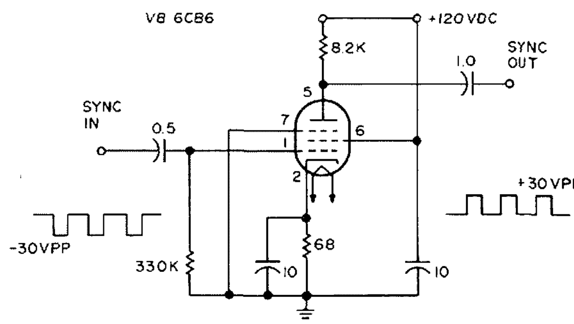


Fig. 3. Sync amplifier.

Composite Sync Amplifier

This amplifier is located on the sync shaping generator chassis and is not located on the camera unit. Although there is no reason why this could not be performed.

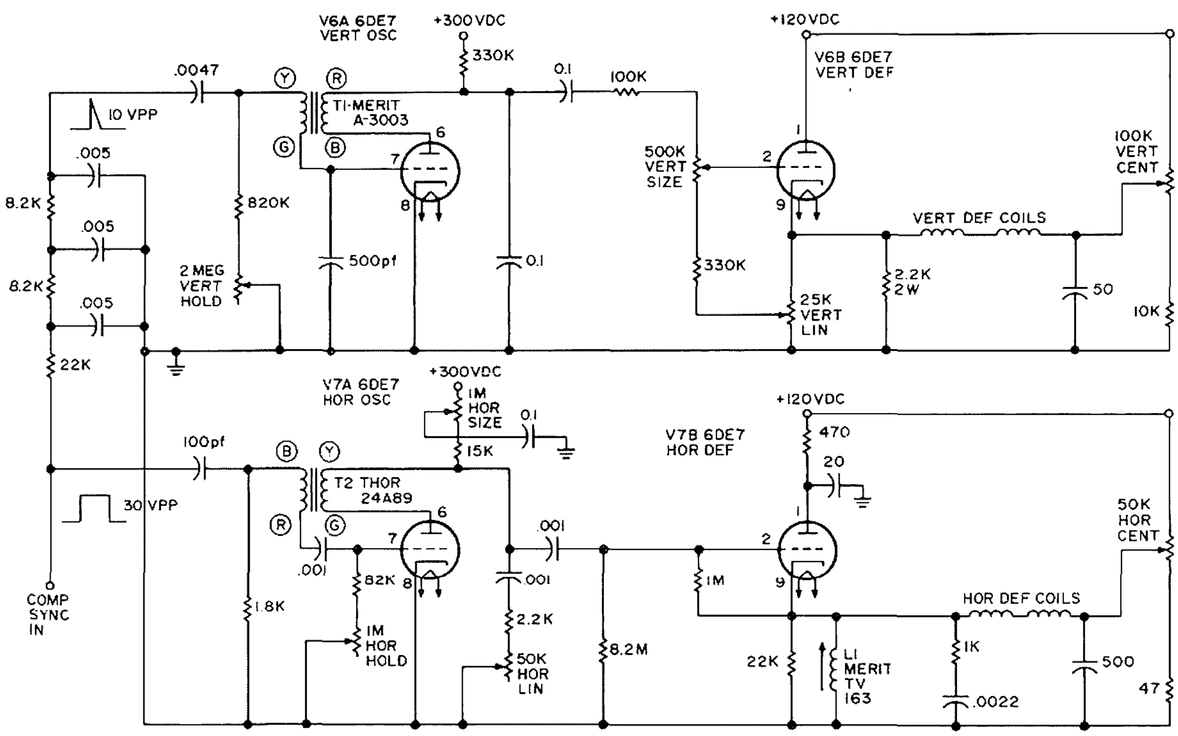
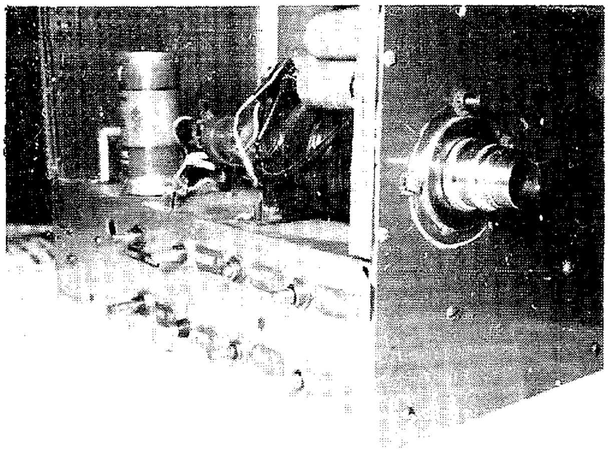


Fig. 2. Sweep and deflection circuits.



The other side of the camera with the vidicon and focus coil mounting, along with the adjustment pots for the vidicon.

The main purpose of this unit is two fold: To change polarity of the composite sync from negative to positive, and to amplify the sync to a usable level. This being in the neighborhood of a gain of 10. The circuit of this amplifier is shown in **Fig. 3.** The composite sync is derived from the sync shaping generators (this is with the sync delayed 1.25 us). There is no delay in the vertical sync.

Composite Blanking Amplifier

Fig. 4. is the schematic of the composite blanking amplifier for the vidicon camera tube. The sole purpose of this amplifier is to increase the amplitude of the blanking pulses

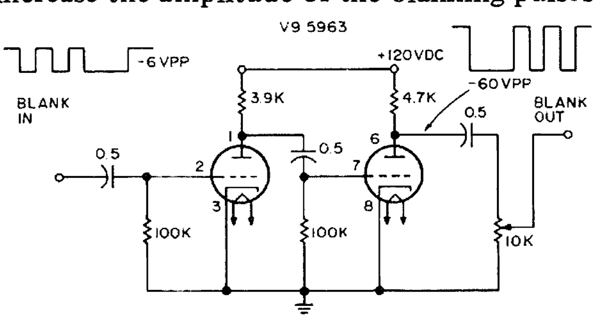


Fig. 4. Blanking amplifier.

to a level which the camera tube will cut off. For the 6326A vidicon, the level is a minimum of -30 volts. Again this amplifier is remotely located on the video mixing amplifier chassis, which, by the way, could be mounted on the camera chassis proper. A means of adjusting the blanking level is provided. This value being dependent upon the particular vidicon used.

Vidicon and Focus Coil

Fig. 5A is the schematic of the vidicon socket connections with the various voltages which are required. Deviations from the original circuits will be noted. The cathode of the vidicon is (pin 7) grounded. The target current and its associated circuitry is still located in the video preamplifier. All voltages are virtually the same as in the original article

Another change that was made was the isolation of the focus coil from the horizontal output stage. This circuit is noted in **Fig. 5B.** The best focus condition was found when a current of 37 ma was flowing through the focus coil. This coil is identical to the original.

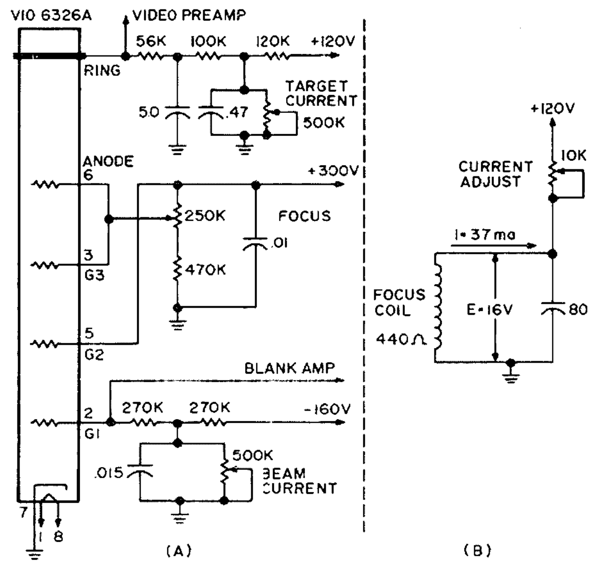


Fig. 5. Vidicon and focus coil.

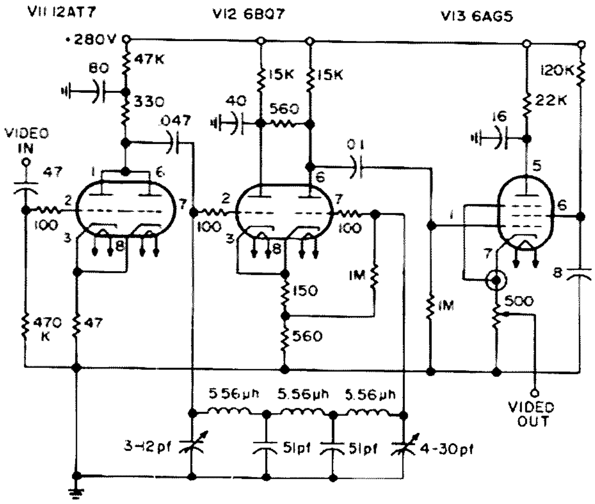


Fig. 6. Aperture corrector.

Aperture Corrector

Horizontal resolution is affected by the spot size of the electron beam scanning the photo sensitive area of the camera tube and also by lens aberrations. This resolution can be improved by using an aperture corrector. Just such a unit is shown in **Fig. 6.** V11 and V12 are the aperture corrector stages. V13 is a cathode follower. The 500 ohm resistor shown in the cathode circuit is in reality the gain control in the video mixing amplifiers. This is indicated to simplify the schematic. The time delay line provides high frequency boost with a linear phase characteristic throughout the whole video range.

The time delay line is a half wave at 9 mhz. Low frequency response and gain is not affected, and maximum high frequency boost is obtained with the circuit as shown.

Blanking Generator

At this stage I thought it would be a good idea to also throw in a diagram of the composite blanking generator. **Fig. 7** is the schematic of this unit. V14 is the vertical multivibrator. Two controls adjust both the repetition rate and the pulse width. The same applies for V17 which is the horizontal multivibrator. V15 is the mixer, where both the vertical and the horizontal pulses are combined to form the composite blanking pulses. The clipper stage and the cathode follower being V16. Sync pulses are derived from the sync timers, which are a series of dividers.

The system which I have been using is now a few years old, and has been relatively maintenance free. Interconnections of signals are with coaxial cable, where it is required. Shielding and good grounding of all units is very desirous.

. . . W8VCO

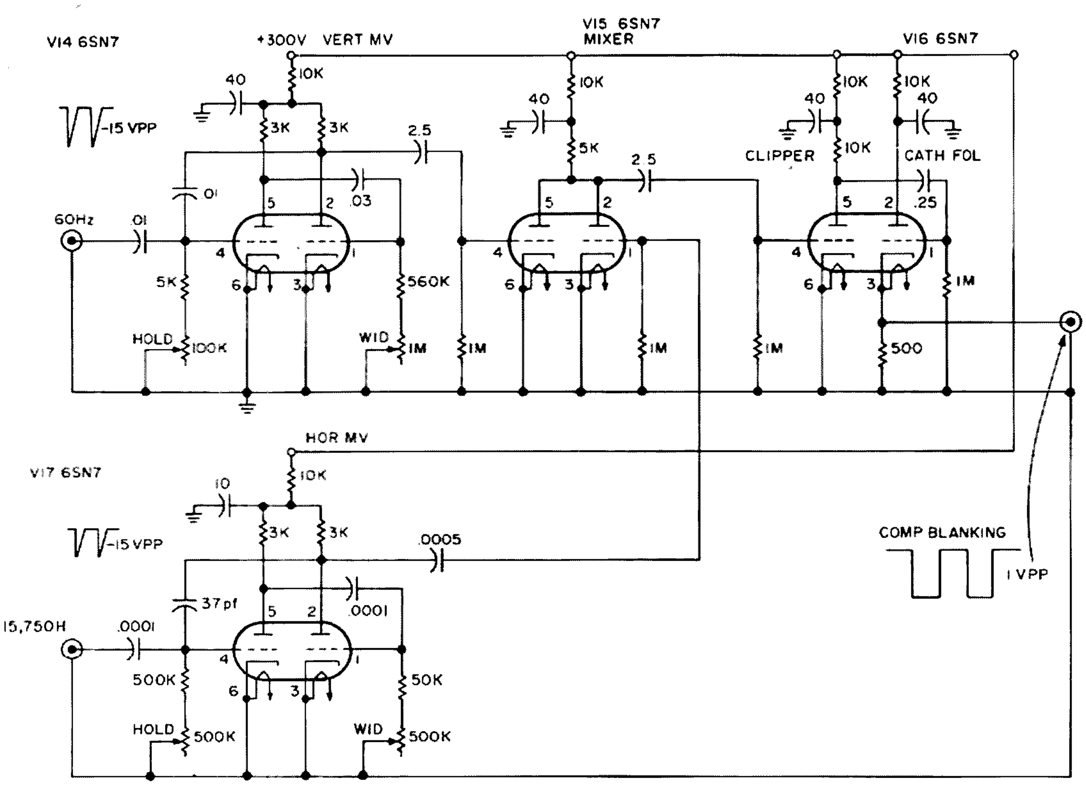


Fig. 7. Blanking generator.

Two More Transistor Testers

(Haven't you built one yet?)

Herb Schoenbach W9DJZ
3919 Earlston Rd.
Downers Grove, Ill.

If you have built one or more of the many simple transistor testers which have been described over the years, here is a modification that will give you a direct reading beta scale. And, if you haven't built one yet, one of the two adapters to be described here should be right up your alley. But, if you are not quite ready to build one, read the article anyway and you just may change your mind. These adapters are really simple and come as close to being one-evening projects as you are likely to find. Before I get to the construction part, let me tell you how I stumbled onto this direct reading feature.

Many years ago while working on a transistorized electronic organ project in my basement, I built a test adapter for use with my VOM using circuit of Fig. 1. This is a little gem which served me well. Much as I would like to give proper credits, the publication where this appeared is no longer in my library. And you may see a similarity to circuits appearing in trade journals [1,2] as well as Darrell Thorpe's circuit in the January, 1967, issue of *73*. There are two equally effective ways of using this type of tester for measuring dc gain, or dc beta (also known as hFE), and most testers of this type use one of the two.

Method one: To make the beta measurement, simply adjust RB starting with maximum resistance, until the voltmeter reads one half of the battery voltage. Neglecting the slight voltage drop from emitter to base, half the battery voltage appears across RE as read on the meter, and the voltage across RB will be nearly the same. Under these conditions: IC=E/2RE; IB=E/2RB; beta (hFE)=IC/IB; then beta=RB/RE.

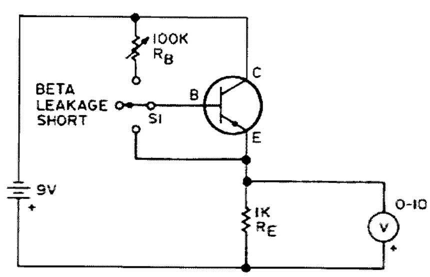


Fig. 1. Basic circuit of a popular and simple adapter for testing common "milliwatt" size transistors.

By marking the dial of RB in even thousands of ohms, beta readings are obtained from this dial. I built my tester with an RB pot of 50 k originally, because in those days transistors seldom had betas over

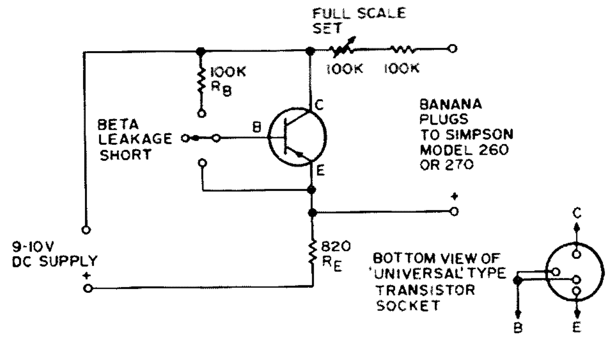


Fig. 2. This circuit will provide direct reading of transistor beta right on your VOM ohm scale. Polarities are shown for PNP type.

20. As the state of the art progressed, even 30-cent transistors started showing betas close to 100, so I changed RB to a 100 k pot. What if betas go over 100? Well, I didn't change the pot again; I just went to method two.

Method two: set RB to 100 k or replace with fixed resistor of this value. Next make up a table of values from the formula:

$$\text{beta}=\frac{\text{meter reading in volts}}{\text{battery voltage} - \text{meter reading}} \times 100.$$

By using a 10-volt supply and a 10-volt meter scale, the table comes out like this:

Meter Reading in Volts	Beta
2	25
3	43
4	67
5	100
6	150
7	230
8	400

At this point I could have made up a special scale but still did not have a spare meter to commit to this service. So I was quite satisfied using the table. For years I went on in this primitive way in an age of digital instrumentation till a thought tremor

went through my noggin. One end of the meter scale represents a beta of zero and the other end of the scale represents infinity. But wait! My ohmmeter scale is already marked this way. Only in reverse . . . and besides, the middles of the scales would never match. Or would they? A check of the formula for calibrating a series circuit ohmmeter and the formula for calibrating my transistor tester meter showed them to be similar. But by connecting the meter across the transistor instead of across RE, the formula reduced to the same form. Check this for yourself if you like algebra problems.

Construction

Fig. 2 is the schematic of an adapter made to plug directly into a Simpson model 260 or 270 VOM. Make sure the banana plugs are spaced 5/8 inch to match the Simpson spacing and not the standard 3/4 inch. Polarity reversing is done by reversing the battery and the meter polarity switch. But play it safe by keeping the VOM on the 250 volt range till after the battery is connected. Then, if your hook up is correct, the needle will deflect upscale slightly. Now switch to the 2.5 volt range and set the 100 k pot for full scale volts (zero ohms). Next insert transistor to be tested in test socket. Check as follows:

Switch Position	Reading	Result
Short	2.5 v	OK
	near zero	Collector shorted or wrong type Xstr.
Leakage	2.5 v	very low leakage (normal for silicon)
	2.2 v	some leakage (normal for germanium)
	2.0 v or less	excessive leakage
Beta	Read ohm scale & multiply by 10	

Note that a transistor which shows "shorted" in the Short position may be the opposite type (NPN or PNP) than you have set up for so don't discard it yet.

If you are adapting this circuit for another model VOM, you may have to use different values for RE and/or RB. Keep RE somewhere near 1,000 ohms. Note what your particular ohm scale is marked at exactly center, referring to the dc voltage scale. If this center scale ohm reading is 10, for instance, call this 100 for your transistor beta scale. Then RB/RE must be made to equal 100. If the center scale ohm reading is 30, you could make this come out to either 30 or 300 for your beta scale. Just make RB/RE equal 30 or 300 to correspond. On

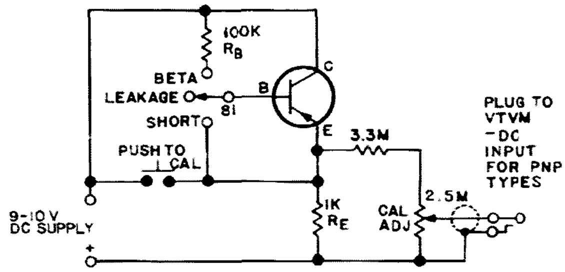


Fig. 3. Here is the direct reading version for use with V.T.V.M.'s. Notice the similarity to **Fig. 1.** Again, polarities are shown for PNP type.

the Simpson 270, the center of the ohm scale is 12, so I wanted this to be 120 for beta: Therefore I made RB/RE equal 120. (100 k/820 is approximately 120 and plenty close for this purpose.) In case your VOM does not have 20,000 ohm per volt sensitivity, you will also have to reduce the values of the *full scale set* resistors to give smooth control at full scale.

VTVM Version

Fig. 3 shows the circuit for use with VTVM's. It's almost the same as the one I started with but it also will give direct beta readings on the ohm scale. Notice that the meter is back across resistor RE where it was in **Fig.** 1. This works for VTVM's which have an ohm scale reading in the same direction as the volt scale. That is, zero ohms is at the left end of scale and infinity at the right end. Construction details are up to you for this adapter and for the previously described

TVI on all three networks – huh Dick? Well, send Spiro over and I'll give you a high-pass filter . . . .

one; open breadboard or enclosed, temporary or permanent, doesn't matter. Follow the schematic and they'll work. You can make this one plug into your VTVM if you wish, but on mine I used a short connecting cable to reach my VTVM on its shelf. Operation procedure is also similar to the VOM adapter; however, full scale is adjusted by holding pushbutton and adjusting the 2.5 M pot. Set the VTVM to dc volt range, about 3 to 5 volts full scale. Resistor values shown in Fig. 3 are for VTVM's having 10 (or 100 or 1,000) at center of ohm scale. For other center scale values proceed as before; keep RE near 1,000, but make RB/RE equal desired center scale beta value to match your VTVM. Having set full scale using the pushbutton, plug in or connect the transistor to be tested. Check as follows:

Switch Position	Reading	Result
Short	0	OK
	near full scale	Collector shorted or wrong type Xstr.
Leakage	0	very low leakage (normal for silicon)
	0-10%	some leakage (normal for germanium)
	10% or more	excessive leakage
Beta	Read ohm scale & multiply by 10	

Conclusion

Watch out for some of the new epoxy or economy packaged transistors, as several manufacturers are using unconventional basing and the base connection is not always in the middle. Maybe future transistor testers will get to look like tube testers with fifty or so sockets! So · better consider providing some extra sockets or at least three binding posts for clip leads. It should be understood that several assumptions have been made in designing these simple testers, and the effects of leakage, or ICO, on the beta reading have been ignored. But nevertheless they are very useful gadgets. So pick the circuit that matches one of your VOM's, scrounge up the parts, and build. If you already have a simple test adapter, just a few changes will give you the "direct reading" feature. Then go through your junkbox and check about fifty of the little unmarked devils. You'll be surprised how fast you can read those betas.

. . . W9DJZ

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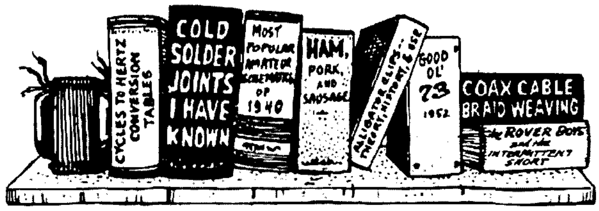
1. *Small, Simplified PNP Beta Tester* by Benjamin H. Rose, Eatontown, N.J., **Electronic Design**, July 22, 1959
2. *A Do-It-Yourself Transistor Tester* by E.J. Crossen, Blue Bell, Pa., EDN May 1966



NEW BOOKS

Ham Radio Incentive Licensing Guide

This hard cover book, written by Bert Simon, W2UUN, has been prepared with the aid of FCC. It covers every question which may be encountered on every amateur test from Novice to Extra. The questions are presented in the form you find on the actual exam.

In addition to the question/answer sections, the book goes into detail on learning code, the requirements for each class of license, details on how to fill out the form 610, and the examination schedule for the various FCC offices. There is also a chapter devoted to the schematic diagrams needed for the exams.

This book does not profess to teach theory and is simply a question and answer book. Theoretically, someone with a good memory could squeeze by the exam using this guide. I suggest that this guide be used in conjunction with a sound theory course such as the one which has been running in 73 since March 1968. Available from TAB Books, Blue Ridge Summit, Pa. 17214. Price: $6.95 hardbound; $3.95 paperbound. TAB Book #469.

Trouble Shooting the Solid State Chassis

A brand new handbook detailing specific procedures for servicing all types of transistorized devices. It contains case histories, and troubleshooting charts. The opening chapter details how to isolate a defective transistor, how to remove and replace it, and general test information. The book then goes on to more specific pieces of equipment: TV, small portable transistor radios, ac-dc, AM-FM and multiband receivers of all types, auto radio repair, removal and installation, tape recorder repair (including mechanical details) and ends up with repair of printed circuit boards.

The author, Homer L. Davidson, has presented the most complete and up-to-date information in an easy to understand manner. This book is 256 pages of valuable material for anyone dealing with solid state devices. Available from TAB Books, Blue Ridge Summit, Pa. 17214. Price: $7.95 hardbound; $4.95 paperbound. (TAB Book #495.)

(. . . de W2NSD/1 continued from page 67)

ARRL Elections

Every year one half of the ARRL Directors come up for re-election. Many amateurs feel that one of the very best things that could happen to the ARRL would be to get some new blood into it . . . some new Directors, fellows who would take an active interest in the League and in bettering amateur radio.

Please notice that the subject of opening an office in Washington, even a small one, as a lobby for amateur radio, wasn't even *discussed* by the Directors at this May's meeting. Nor were any plans brought up even for consideration with regard to setting up a public relations effort to increase interest in amateur radio among the teenagers and the general public. Amateur radio is withering away and a crash program is badly needed. Nothing has even been discussed despite considerable pressure from the members.

Perhaps you have a friend or a club member who is interested enough in amateur radio to volunteer to run for Director? You haven't much time to get organized on this, you know. The most difficult part of the whole deal is overcoming the unbelievable inertia of the other ARRL members and getting them to do anything but either not vote at all or else rubber stamp the same old face back into office for two more years of tedium and inaction.

The requirements to run for Director are that you be a licensed amateur (they have interpreted this as meaning a General Class license or better), with four years (continuously) as an ARRL member. If you know of anyone who meets these stringent requirements and who has a genuine interest in helping amateur radio, get him to agree to run. You must send a petition to the ARRL Secretary before September twentieth signed by at least ten full members of the ARRL to put your man into nomination.

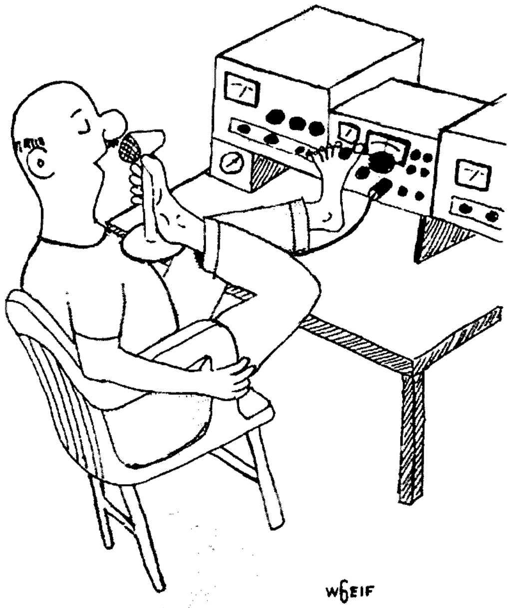
The by-laws state that no one shall be eligible for the office of Director who is commercially engaged in the sale, rental, or manufacture of radio equipment which can be used for communications. They have waived this rule in some cases where a nominee was particularly favored by HQ, but used it to reject others. Radio magazine publishers are also exempted in the by-laws.

The whole thing is really up to *you.* Amateur radio is staggering along these days because virtually no one has taken the interest to try and put it right. For one reason or another everyone has pretty much decided that they want one and only one organization in the country. This is no problem if you follow through and make sure that the basket you have all your eggs in doesn't come unstuck. You've left those eggs alone in the basket for so long that vapors are beginning to arise.

This year new directors can be elected in the Atlantic, Dakota, Delta, Great Lakes, Midwest, Pacific, Southeastern, and Canadian Divisions. If you get busy and get eight new directors this year and then eight next year, we could have amateur radio back on the tracks again by next winter! If you shrug and let someone else run a director, then you will have personally done your bit to help our wonderful hobby die a little more. To ignore evil is to become its pawn . . . as millions of Germans learned all too well when they ignored the rise of Hitler. If you find that you personally don't have the will to try and do something to help amateur radio, at least don't make it difficult for those that are trying. Even a loud huzzah from the sidelines is better than a kick in the groin.

If you do run a director, you will need to know how to get him elected . . . and this is another kettle. If you don't get to most of the ARRL members before the election, they will go right ahead and return the same director, year after year, no matter whether he is good or incredibly bad. The ARRL must furnish addressed envelopes for all of the members in the division on your request, so work up a piece of campaign literature that explains why a new man is running and what he intends to do for the members. The incumbent will usually run on his "record." Fortunately for him, few members are aware of how sad that record is . . . in all too many cases.

The ARRL has been losing members for many years now, so no matter how much you think of those in charge, you must recognize on some level that they are not



"Now I'm running the Swan barefoot . . . ."

doing their job satisfactorily. The League, our only national amateur radio club, should be growing every year, not shrinking. This, certainly, is the final measure of the effectiveness of management. The only real means that amateurs have of protesting the actions of the ARRL HQ management is to drop out of the organization. Much has been written, even in the pages of 73, about joining the League and fighting from within for an improvement . . . but the only means that the average amateur has of expressing his will to the League is in his election of his director . . . and seldom is there any real choice when the election actually comes along. Year after year the same old men run, unopposed, and win automatically. No wonder there is apathy and more drop-outs than new blood.

Honestly, if it was really important, couldn't you find someone to run for director from your division? Well it *is* important, so let's see what you can do.

. . . Wayne

PROPAGATION CHART

J. H. Nelson

September 1969

SUN	MON	TUES	WED	THUR	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Legend: Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7	7	7	7	7	7	14	14	14	14
ARGENTINA	14A	14	14	14	7A	7A	14A	21A	21A	21A	21	14
AUSTRALIA	21	14	7B	7B	7B	7B	7B	14	14	14B	21	21
CANAL ZONE	21	14	14	14	7	7	14	21	21	21	21A	21A
ENGLAND	7	7	7	7	7	7	14	14A	14A	14A	14	14
HAWAII	21	14	14B	7B	7	7	7	7B	14	21	21	21
INDIA	7	7B	7B	7B	7B	7B	14	14	14	14	14B	7B
JAPAN	14	14	7B	7B	7B	7B	7	7	7	7B	7B	14
MEXICO	21	14	14	7	7	7	14	21	21	21	21A	21A
PHILIPPINES	14	14	7B	7B	7B	7B	7B	14B	14	14	7B	14
PUERTO RICO	14	14	7	7	7	7	14	14	14	21	21	21
SOUTH AFRICA	14	14	7	7B	7B	14	21	21A	21A	21A	21A	21
U. S. S. R.	7	7	7	7	7	7B	14	14	14	14	14	7B
WEST COAST	21	14	14	7	7	7	7A	14	21	21	21	21

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PUERTO RICO	21	14	7	7	7	7	14	21	21A	21A	21A	21A
SOUTH AFRICA	14	14	7	7B	7B	7B	14A	21	21	21	21	21
U. S. S. R.	7B	7	7	7	7	7B	7B	14	14	14	14	7B

WESTERN UNITED STATES TO:

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U. S. S. R.	7B	7B	7	7	7B	7B	7B	7B	14	14	14B	7B
EAST COAST	21	14	14	7	7	7	7A	14	21	21	21	21

A—Next higher frequency may be useful this period
B—Difficult current this period

Ted Williams, WA0IOC
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Clinton, Iowa 52732

The FET Compressor

The addition of a speech compressor to your rig is a worthwhile project. A speech compressor will not only increase your talk power but also reduce flat topping. The simple circuit described here uses two Motorola HEP 801 Field Effect Transistors. The entire unit can be built for approximately $15 or less, depending on the size of your junk box.

Features

The compressor has an overall gain of unity. Therefore, the output of the circuit is comparable to the output of the microphone connected to it. This is accomplished by the voltage divider R3 and R4 in the output. If for some reason more output is required, the value of R4 may be increased provided the value of R3 is decreased by an equal amount. In other words, the sum of R3 and R4 must remain approximately 70.2 ohms.

Because of the inherent high impedance of the HEP 801's, the input impedance of the compressor is determined almost entirely by R5. The value of R5, 470K ohms, is not critical and may be changed to match the output impedance of any high Z microphone. However, the 470K ohm will provide a good match for most crystal, ceramic or dynamic microphones. At high signal levels, a 6 db change in the point will result in only 1 db change in output. The circuit also has an inherent threshold voltage of approximately 10 mv. due to the characteristics and operating point of the FETs.

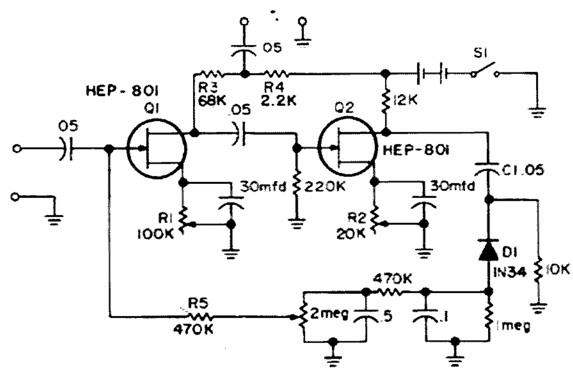

Fig. 1. Audio Compressor using two HEP-801 FETs. All resistors ½ watt, all capacitors are in μf.

Circuit Operation

The compressor is composed of two audio amplifiers, an AGC rectifier and an AGC circuit. The output from the microphone is amplified by Q1 and then capacitively coupled to Q2 where the signal is amplified further. The output from Q2 is coupled through CI to the AGC rectifier, D1, and is rectified. The rectified audio is then filtered and fed through the AGC circuit and applied to the gate of Q1 as negative bias.

A small input signal will develop very little AGC voltage and have little or no influence on the circuit gain. A large input signal will develop much more AGC voltage. This large AGC voltage will reduce the transconductance of Q1, Thus lowering the circuit gain considerably and resulting in an output that is only a few db greater than that of a small input signal.

Construction

The compressor was built on a 2½ by 4¼ piece of perforated bakelite which was then mounted in a minibox. The size of the unit can be reduced through the use of miniature components.

The FET used as Q1 must have a low pinch off voltage. To determine which transistor has the lowest pinch off voltage, the source and gate leads should be temporarily connected together. The resistance from the drain to the source is then measured with a VOM or VTVM. Whichever FET shows the highest resistance reading should then be used as Q1.

The parts layout of the circuit is not critical if proper construction methods are followed. In the original unit three pieces of buss bar were run across the board and used as tie points for the B+, ground and AGC line.

Adjustments

The resistors R1 and R2 should be adjusted to give maximum output. This is done by placing the compression level at minimum and then measuring the voltage across R6. The value of these resistors is critical and pots had to be used. Fixed resistors were used at first but failed because the nominal values were not accurate enough.

When these adjustments are complete, the compressor may be inserted in the microphone line. With the compression level at minimum, adjust the audio gain on the transmitter as normally. The compression level can then be raised to the desired level. The audio gain can now be raised again until the output meter peaks at the same reading as it normally did.

Operation

Two 9-volt transistor radio batteries were used to supply the B+ to the circuit. The compressor draws only one mill so battery life should be very reasonable.

Besides increasing the talk power of your rig and reducing flat topping, the circuit has many other advantages, depending on the operating practices of the builder. For example, the man who runs phone patches will no longer have to continually reach for the audio gain when the caller changes the level of his speech.

I would like to extend my sincere thanks to Lee Michaud, K8OOV, for his assistance in designing and testing of this compressor.

. . . WAØIOC

Roger D. Farley, WA2YRF
Box 104
East Schodack, New York 12063

The Mike Mixmaster

This little device is so simple that most hams just never think of it. If you're operating push-to-talk, however, it will transform every microphone in your shack into a push-to-talk mike. The switch in this piece of gear will also trigger your transmitter, leaving hands free for logkeeping, minor adjustments and the like.

I'm control station for a civil defense net, and one day I began wondering what I'd do if my microphone conked out unexpectedly. I have a number of other mikes in the shack, but none of them are the required push-to-talk type necessary to key my transmitter. In an emergency, rigging up a substitute would take precious minutes – finding a switch and the proper plug and making the right connections to operate the rig. I reasoned that if I had a microphone mixing box with some kind of a switch which could fire-up the transmitter, I could use any mike in the shack in an emergency. I could also compare their modulation capabilities, using the same box.

By pouring the contents of my junk-box on the floor, (which I find is the easiest way to locate anything) I came up with the necessary jacks to match my assortment of mike plugs. In my case, these were a standard phono connector, an RCA-type phono connector, a quarter-inch two-circuit, and a quarter-inch three-circuit phone plug. In the same mess was a switch that I had picked up for 25 cents at a fire sale when one of the local radio stores burned down. Pushing this switch in one direction makes a momentary contact, and in the other direction, it latches. The switching operation is similar to that of the Heath Twoer and Sixer.

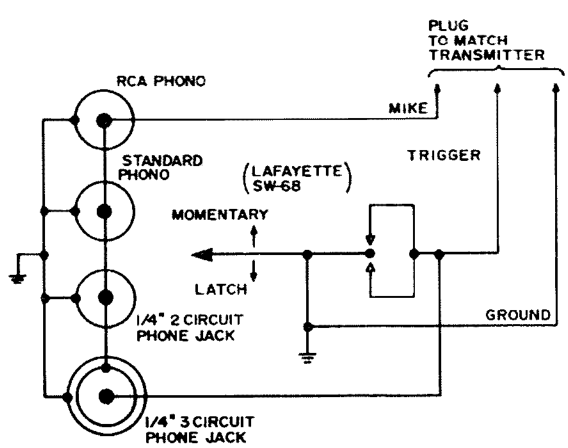

Fig. 1. The WA2YRF Mike-Mix-Master.

Wiring is simple, as you can see from the schematic. The various jacks are in parallel and the one matching the push-to-talk microphone is wired straight through. The switch is wired so it will key the transmitter when it's pushed in either direction.

Layout of the jacks and the switch is not critical, nor is the size of the chassis used for the project. I used a mini-box which was larger than necessary (3 x 4 x 6), looking forward to the day when I might dream up a transistorized VOX circuit to make the unit even more versatile. It's wise to leave room for more jacks in case you obtain more microphones in the future. To minimize the possibility of hum pickup, I kept all my wiring close to the chassis, but I don't believe this would be a problem. I have had no bad modulation reports.

One improvement which might be made is to make the output lead to the transmitter "plug-inable," and make up a variety of leads for each of the different types of transmitters you have in the shack. With this feature, you can use it as an all-purpose microphone adaptor. I've even had three mikes (a ceramic, a crystal, and a dynamic), located at strategic points about the room, plugged in at once. This works just fine if you have plenty of audio and want to move around the room while transmitting.

Build it. It's handy, compact, and even if you don't use it, it doubles as a dandy paperweight and conversation piece.

. . . WA2YRF

Ralph J. Irace, Jr., WA1GEK

The T-60 Works Just Fine

As I neared Mac's QTH, quite exhausted after pedaling uphill several hundred feet, the tall seventy-foot towers glistening in the sun with all the grandeur of tri-band beams, quads, stacked yagis, amongst other mouth drooling additions, came into rapid sight. "Gee," I thought, "those dipoles of mine sure are crummy." Gazing at the antenna complex admiringly, I reached the gravel driveway, parked my bike and walked toward the back door. I rapped on the door a few times. I heard approaching footsteps. "Hi Scott. How's the ole T-60 coming along?"

"Oh pretty good I suppose," came my pretty-well-standard reply. Mac motioned for me to enter and follow. Within a duration of seconds, I was in his enormous shack. He sat himself in a comfortably cushioned swivel chair while I took refuge on a three legged stool. For once I decided to start the rag session.

"How's the new quad working on 40, Mac? Looks like a real swell skywire, hi" my voice crackling.

"Ahh, it's not too hot a performer actually. I'm having a chore trying to load it for some odd reason. Thought the problem might be in the 32S-3 but I gave it a looking over yesterday and couldn't find the problem. I bought the best coax in the store too."

"Perhaps I can help," I said, walking toward the console. Mac appeared slightly annoyed. "Say, Mac," I said after a minute or less, "this connection you have on the coax plug looks pretty poor. In fact the center conductor of your coax is wiggling around."

"What?"

"Yeah. Right here. See?"

Mac was clearly upset but tried to pretend as if nothing was at fault. "Can't be such a small thing like that—maybe the balun or my antenna is kaput or something. I'll find the trouble for sure later on."

"All right Mac," my voice quivered slightly after seeing Mac in such a state of aggravation. I had idolized Mac for many months because of the fine DX record he had and most of all because of his fabulous station.

He dismissed me promptly . . . "Let me know how you make out on the contest this weekend, Scott. I've got to mail out a batch of QSL's now."

"Okay Mac, I know you'll take first place in the contest. Don't forget to work me. Bye."

After getting back to my own shack, I surveyed the scene and decided that some final preparations for the weekend contest had yet to be made, so I set about doing them. As I was touching up a few things around the station, I wished that I was the owner of a station like Mac's. If only I had the money! This T-60 is like an insect compared to his transmitter. Golly, his antenna farm rivals those of broadcasting outfits. I'll be lucky if I get even twenty percent of Mac's contacts during the contest, I thought to myself. While outside checking and rechecking the antenna supports and connections, I saw Mac's towers off in the near distance up on the hill. "Shucks – just maybe someday I'll be able to have one small tower, then Mac won't kid me anymore about my small station."

Well, the contest came and went. I worked as long as my parents permitted and tallied up a final score of 2,785 points, probably nothing compared to what Mac had racked up.

After I completed copying the scores onto the final sheets, I mailed them off for placement in the score list; I was probably at the bottom and Mac at the top. I then went over Mac's house and was greeted by one of

his family and shown into Mac's shack. It was in complete disarray. Transmitters, receivers, power supplies, swr meters, etc, were scattered all about the shack, obviously after being worked upon. Mac and I exchanged mutually surprised greetings. Mac slumped heavily into his chair and looked exasperated. I asked what the trouble was, and for once he conceded defeatingly that he didn't know. "Maybe I can be of some help," I said with Mac even looking more annoyed than he had on my previous visit. I hesitated at seeing Mac disturbed but then thought that perhaps I really could help. Then I turned up the culprit. "Say Mac, I don't even think your getting a connection here between the antenna plug and SO-239. Look, there's hardly a bit of solder on the plug tip and the center conductor has slipped down . . . I doubt if you're even getting twenty percent efficiency from your transmitter output to the antenna. I'll bet this is the reason why. . . . "

"Would you like to be my official station maintenance man, Scott? I could provide you with a lot of opportunities to work with my antennas, climb my towers and even use the S-line here, if you like. You'll find it quite a thrill over that little T-60 you use . . . how about it?"

I thought for a few seconds and then realized that even hams with big stations can make blunders over little errors when they let themselves become possessed with inflated egos and visions of grandeur because of the extra-large stations they have. I was sorry Mac didn't work the contest for apparent reasons. "No thanks, Mac. The T-60 is just fine, just fine." And this time I went home without even glancing at his antennas.

. . . WA1GEK

Dave Mann, K2AGZ
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Kinnelon, New Jersey 07405

Leaky Lines

I'd like to share a little vignette with you . . . hardly worth mentioning but for its utter incongruity. It fails to make any sense whatever to me.

I think, somehow, there's nothing more ridiculous than a man with delusions of grandeur, pushing his heft around, trying to prove himself a big shot. And whom does he select for his target? Generally someone with more importance and status than his own. It's a truism. Some little squirt with a chip on his shoulder and a snoutful of booze invariably picks the biggest, burliest fellow in the saloon and provokes a fist fight with him. Well . . . just get a load of this type and his antics.

In connection with the Apollo 10 mission, WB4ICJ, club station of Space Center Amateur Radio Society (SCARS) at Cape Kennedy, operated for about ten hours last May. The club offered a handsome special event certificate to all stations contacted. Over 900 QSO's were logged, including 80 odd from 23 foreign lands. The frequency was 14.340 mhz., and operations commenced on the morning of the liftoff.

Sometime during the evening hours a station came on, and the operator *commanded* WB4ICJ to relinquish the channel because, in his words " . . . it is used daily by ICHC, IFHC and ISWL-CHC." Is this combination of initials intriguing? Well, they were intriguing to me, so I looked them up. They stand for (1) International Certificate Hunters Club, (2) International Flying Hams Club, and (3) International Short Wave Listeners Certificate Hunters Club, respectively. Now, don't get me wrong. I'm not trying to imply that the SCARS operation was of first-magnitude importance. But you'll have to admit that these certificate hunter groups were certainly not engaged in high priority matters either.

I am reminded of an incident which occurred while I was on jury duty some years ago. I had been chosen, along with eleven other people, to sit on a case. The lawyers were asking us various questions to determine our qualifications as jurors. One of us was an insignificant looking mouse of a guy but pompous as a rooster, and who had a constant sneer on his face as if he were smelling something unpleasant. All during the preliminary stages, before we had even been selected for the panel, this weasel had been asserting the obvious guilt of the defendant, even though not one single fact had been presented in evidence.

"And what is your line of work," he was asked.

He answered the attorney imperiously, with exaggerated hauteur: "I am the president of the American Cigar Band Institute." Everyone looked at him with new-kindled respect.

"You manufacture cigar bands, do you?"

"No," he answered, somewhat chastened, as his bubble burst. "We collect them!"

The entire courtroom, including His Honor, rocked the building with a peal of spontaneous laughter, and the little peacock slumped down in his chair, deflated.

Well, anyway, to get back to the story, the interloper stated that this group of his was about to start its net, which had been using this frequency for years, and that the NASA group had certainly known of this from the beginning, hence was guilty of stealing the frequency, Ugly Americanism, poor sportsmanship, etc., etc. . . . ad nauseum.

He stated further that if they did not vacate the frequency he would use his influence as an editor and publisher to make sure they were penalized for their " . . . obnoxious, ungentlemanly conduct." He accused them, among other things of " . . . deliberate interference," notwithstanding the fact that his certificate hunters were nowhere in evidence during the period when the Apollo 10 activity had commenced operations. In other words, these certificate hunters clubs were nationally famous, and every ham was aware of their existence and of their net activity. Well, I must confess that I had heard of certificate hunters. But I had no idea that they operated a net on 20 meters. This man conveyed a distinct impression that his group had a lock on this particular frequency, and that no one had better use it, because it belongs to CHC and the others – lock, stock and barrel, now and forever, world without end, in perpetuity, case closed, period!

The operator of SCARS, who hadn't heard of CHC either, obviously not wishing to engage in a time-consuming dialogue, particularly since the complaining part was becoming more and more abusive, suggested that he send a copy of his promised editorial to the radio club. Then he proceeded with the space shot contacts.

In due course a letter was received by the Public Relations Director of National Aeronautics and Space Agency at Houston, and a copy at Cape Kennedy. The "letter" is lengthy, verbose, lugubrious, vehement, fractious, rude, egocentric, supercilious, obnoxious, nauseating, rambling, irrational, and has neither validity nor merit. It is of no consequence whatever. It is like the proverbial

burst of afflatus in a gale of wind.

If that were all it meant, I wouldn't have mentioned the incident at all. But, unimportant though it is, there is one thing about it which is very important indeed. The letter contains a series of threats, both direct and implied. And this merits not only attention, but strong condemnation. It reflects a most intemperate attitude all too prevalent nowadays. This man's use of the term, blacklist, in the context of today's world is an abomination; a stench in the nostrils. The blacklist is an undemocratic, totalitarian disease, which can infect society like a plague, destroying the very fabric of our democratic institutions.

He also writes, instructing NASA, – "You would do well to insure that this could never happen again."

The unutterable cheek of the man! He knows, as you and I know, no one has a priori rights to a frequency. I knew that we had some peculiar people in our midst. But I did not suspect that we harbored out and out lunatics. With two letter calls, yet!

* * *

During the Swampscott convention, I found another piece of literary garbage, also deserving of attention because of its complete lack of awareness of the outside world. It's sad to hear the ravings of a poor, deluded soul, totally out of touch with reality.

This misbegotten piece of drivel was issued by a group called – are you ready? – the National Association for the Advancement of Amplitude Modulation. Can you believe it?

Please understand this: I am not opposed to the use of AM at all. In fact, I rather enjoy listening to it. There is much to be said for the nice audio quality with the soothing low frequencies a la broadcast stations. What I find objectionable is the constant proselytizing, either for or against one mode or another. I don't find it any more palatable in ham radio than in religion. I feel that it's my own affair, and nobody else's damned business.

According to this leaflet, anyone who operates single sideband, using a rig not designed and built by himself, is some sort of microbe. He is called a variety of names, any of which would buy him a punch in the nose if uttered face to face. Here are a few quotes:

" . . . a more glorified form of Citizens' Band."

"After all, any idiot can buy an appliance . . . plug it into a wall outlet, and make noises."

" . . . plugging in an appliance and creating meaningless chatter on the ham bands."

"Amplitude modulation isn't a dirty word." (This is funny, for obviously, single sideband *is* a dirty word.)

"There is great potential in AM. Why not look into it someday?"

Somehow this tawdry little scrawling graffiti gives me a feeling of melancholy. To think there are such benighted little guys, running around unrestrained, hopefully trying to start ground swells of opinion which will inundate the collective intellect like a mighty tidal wave of reformation, and turn back the clock. Like the song laments, Ah, for the dear dead days beyond recall.

These people remind me of the homely little shop girls and tired drudges, hoping to find romance, who queue up at the five and dime, buying cheap perfume and loud, tasteless jewelry; answering the pulp magazine ads that shriek, "Win your man and hold him forever by using our miracle product to increase the size of your bust!"

What a waste of time and energy! And how cruel!

* * *

Those of you who have read some of my meanderings and ruminations are aware that a follower of precedent or convention I'm not. I believe that traditions are made to be broken. Indeed, were it not for this, hardly any progress would have been made since we emerged, dripping, from the primordial ooze. Somebody has always had the guts to say, "enough already." And this tendency will ultimately result in the conquest of humankind's oldest enemies; famine, war, ignorance and pestilence.

Nonetheless, there is much to be said for traditionalism, with its time tested values and verities. It is pointless to turn over the applecart unless there is a more efficient conveyance to take its place. I think there are far too many who scream for change merely for its own sake. There is no percentage in change without progress. When change means chaos, it is folly not to sit tight. Yet, over-cautiousness pays a poor dividend.

Most of us deplore the violence taking place on the campuses. It is too bad that the meaningful aspects of the student movement are being ignored because of the ugliness and anger of the confrontation itself. We are apt to disregard legitimate gripes and grievances because of the utter stupidity and over-zealousness of the militant extremists on both sides of the controversy.

Kids today are not placid, me-too-ers. They are not Pollyannas, nor do they hold with Voltaire's Doctor Pangloss that this is the best of all possible worlds. We elders display unbelievable naivete if we fail to perceive that the world is in pretty sad shape.

I believe, actually, that this is the best crop of youngsters we've ever had. They are not satisfied with the things that motivated prior generations. They are not willing to barter their integrity for automobiles or their concern for truth and justice for membership in the Country Club. They are far more interested in doing away with injustice than in acquiring material wealth or social position. And they mean to make the Constitution more than just a collection of flowery words and phrases.

What has this to do with Amateur Radio, you ask? Only this: On the air, there has been a lot of talk about what should be done about this group and that. Among others, our youth have been singled out and attacked viciously. I am appalled at some of the proposals I've heard on the bands. I cannot imagine any rational person saying this, but someone was heard to advocate "standing them up against the wall and shooting them." Another proposed that they be "strung up." I was under the

impression that this type of philosophy died in a bunker at the Berlin Chancellory with its chief protagonist, back in 1945.

This younger generation of ours, splendid in its energy and vitality, more mature in its goals, earnest in its desire to implement the very best American ideals and the basic tenets of the Judeo-Christian ethic, is being shamefully and slanderously villified. All are being blamed for the sins of a negligible few. How dare we fasten collective guilt on an entire group, after living under the blessings of a form of government whose very basic premise is exactly the opposite? How can anyone who loves America take a position which does her so much harm?

And who does all this talking on the air? Who are those, without sin, who are so ready to cast the first stone? Who are these sanctimonious ones who criticize our youth, our poor, our minorities, our political leaders, our clergy; in short, anyone and everyone?

They need not be pointed out. They know who they are. There is no point in disclosing their identity. If I could speak to them, I would say this: Listen, all you self-appointed super-patriots. Who do you think is doing all the dying in Viet Nam? Who did all the dying in Korea, and in your war and mine, back in the 40's? The kids; that's who! And among them, don't ever forget, there are black and white, rich and poor, educated and unlettered. They're out there, laying it on the line, while you and I are sitting in the ham shack, leisurely enjoying the comforts of home, making pronouncements and judgments. Maybe we ought to take a breather and just listen to what they have to say once in a while. How about it?

Well, there it is, and, like the old bromide says, let the chips fall where they may. My father used to say, "Maybe the truth will hurt, but sooner or later it's going to be said. So why not get it over with?"

* * *

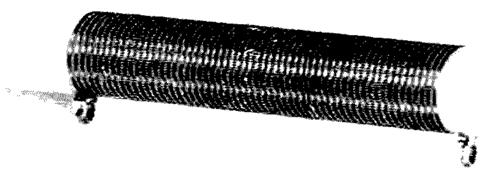
Don't forget. ECARS on 7255, MWARS on 7258 and WCARS on 7255. These are exciting, stimulating and they are of great help to all of hamdom. Give a listen and join in on the fun.

Till next time,

... K2AGZ

A Unique RF Plate Choke

Bill Deane, W6RET
8831 Sovereign Rd.
San Diego, California 92123



A unique rf choke.

At times it is difficult to obtain the exact *rf* plate choke that one may desire for a new final amplifer. In looking for a material to make a 2 ampere 5000 volt dc *rf* plate choke for non-ham use, I came across a material made by DuPont called Delrin. Delrin has high strength but can easily be cut and drilled. It has excellent electrical properties as an insulator with a high heat distortion temperature. These features make it an excellent form for *rf* plate chokes and other coils. Delrin is available in rods of 1/4 inch to 1 1/2 inch diameter and can be purchased in 12 inch lengths. The 3/4 inch diameter was selected for the choke and is available from Allied radio for $1.42 per foot (Allied part 60D9565CF).

The choke shown in the photograph is 5 1/4 inches long. The terminals of the coil are No. 8 brass cotter keys 5/8 inch long. The form is prepared by drilling the two terminal holes on a 4-inch spacing 5/8 inch deep, using a drill slightly smaller than the cotter key size. A 11/32 or 3/8 inch hole is drilled down the center of the rod to a depth of 3 3/4 inches. A 1/2 inch deep hole is drilled in the opposite end of the rod with a 29 drill. This hole is tapped for a 8/32 mounting screw. A 3-inch piece of .33 inch diameter ferrite rod (Lafayette 32C6102) is inserted into the hole and held in place with a few drops of epoxy. Next force the cotter keys into the form holes using a vise or by tapping lightly with a hammer. Sixty turns of No. 20 formvar wire is space wound (15 turns per inch) on the form with the coil ends soldered to the cotter key terminals. The space winding can be accomplished by a dual winding of No. 20 wire and then removing one winding. A light coating of coil dope will hold the turns in place.

The completed choke has an inductance of 90 uh, loafs along at 2 amps, has a Q of 225 at 3.6 mhz and has a series resonance well above the ham bands at 43 mhz.

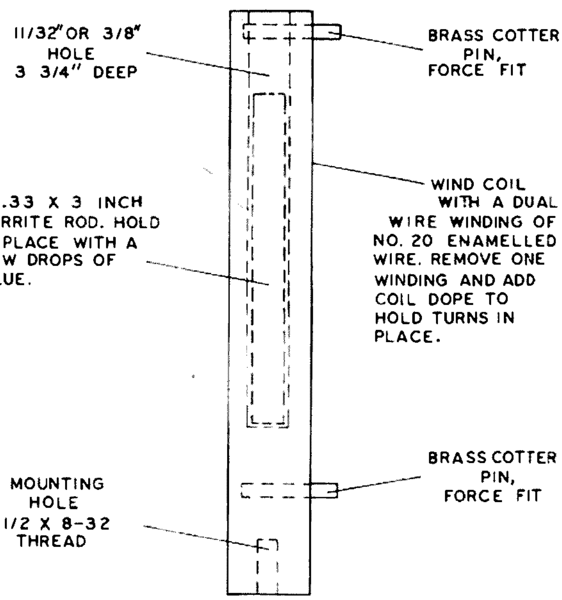


Fig. 1. Diagram of completed 2 amp 5000 volt rf choke using DuPont "Delrin."

If you do not wish to build a choke with the ferrite rod and will be limiting your plate requirements to 800 ma at 2500 vdc, a choke can be wound on a 3/4 X 4 3/4 inch rod with No. 24 formvar wire closewound to occupy 3 1/2 inches. This choke has an inductance of 90 mh, a Q of 160 and a series resonance of 25 mhz. My thanks to Don Bidwell for his photograph of the choke.

. . . W6RET

Modification of the ac Input on the SB-200

Al Brogdon, K3KMO
RD 1 Box 390A
State College, PA 16801

The Heath SB-200 is a real gem, giving top performance per dollar in a linear amplifier. There aré few ways it could be improved, but one feature which falls into the "needs improvement" category is the ac input arrangement.

In the original amplifier, terminal strip "S" has the wires from the power transformer's two primary windings connected to it. To change between 120 Volt ac and 240 Volt ac operation, it is necessary to change jumpers on this strip. This in itself isn't bad, but the ac line plug arrangement is not too good.

Heath outlines the use of a single plug for both 120 Volt ac and 240 Volt ac operation. This is the standard three-contact 120 Volt ac safety plug (two wires plus ground). This could lead to the sad situation of having a 240 Volt ac outlet in your shack which looks like a normal 120 Volt ac outlet, and plugging in a piece of 120 Volt ac equipment with pretty bad results.

To avoid this problem at K3KMO, I installed a 240 Volt ac circuit with a normal 240 Volt ac receptacle, and changed the line plug on the SB-200 to match the outlet. But then came the time I wanted to take the SB-200 to a friend's shack where only 120 Volt ac was available, and I was faced with the prospect of having to change line plugs, re-wire the jumpers on terminal strip "s" to make the change, and then do the same thing again when I brought the SB-200 home.

Rather than do this and be faced with the prospect of doing it other times, I decided to change the SB-200 to come up with an arrangement for simpler change-over. I placed an Amphenol 86PM8 male octal plug on the rear deck of the chassis, where the line cord had previously exited. Fortunately, there is just enough room on the chassis lip to accommodate this connector. I then wired the four leads from terminal strip "S" plus a ground wire to this plug as shown in **Fig. 1.**

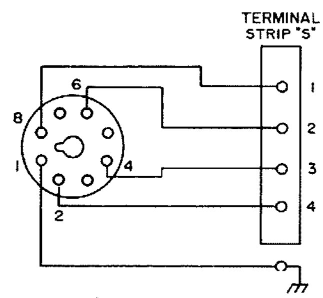


Fig. 1. Wiring changes in the SB-200, from terminal strip "S" to the new power connector (Amphenol 86PM8).

Then two line cords were prepared for the linear, one for 120 Volt ac operation, and the other for 240 Volt ac. The 120 Volt ac cord is the original SB-200 power cord with the plug supplied by the manufacturer. The other end of the cable is terminated in an Amphenol 78PF8 female octal cable connector, wired as shown in **Fig.** 2a. A second power cable was prepared using the 240 Volt ac plug on one end, and another octal connector on the other end, this time

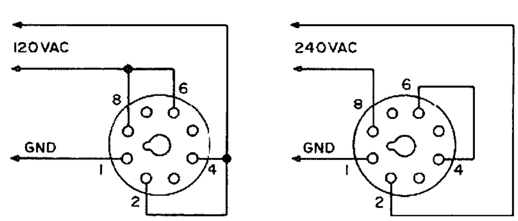


Fig. 2. Connections for the two line cables to mate with the new power connector.

wired as shown in Fig. 2b. Notice that with both power cables, the ac input is connected to the proper transformer leads, and the appropriate jumper connections are also made in the octal connector.

Therefore, the change from one input voltage to the other requires only that the appropriate ac input cable be connected. **Caution:** Be sure all jumpers are removed from terminal strip "S" when this modification is made.

If you are building an SB-200 from the kit, this change can be incorporated as the amplifier is being built, eliminating terminal strip "S" completely. The transformer primary leads and capacitors C1 and C2 can be wired directly to the octal plug. Be careful not to cut the transformer primary leads off too short by following the instructions for normal wiring. Just wait and cut them to length when you're ready to connect them.

This same approach can be used with any piece of equipment which has provisions for either 120 Volt ac or 240 Volt ac line input. And other types of connectors can be used according to your personal preference.

. . . K3KMO

LETTERS

Dear Wayne,

There were several omissions in the schematics of the "Six Meter KW Linear" in the July issue. The most important are as follows:

Page 21. 1. Coil data not given—should be 3 or 4 turns of 1/8" copper tubing, 1" diameter, spaced to resonate with the chosen capacitor.

2. There should be a connector in series with one lead of K1—this goes to the N. O. contacts of the exciter PTT relay.

3. R2 is 100K, ½watt.

4. Cathode pins 2 and 4 should be grounded in addition to pins 6 and 8.

Page 23. 1. Note 4 should read transient rather than equalizing.

Many thanks for the new tower and antennas, the cassette tape recorder, the trip through the Heath factory, and the other things 73 has bought for me in the year I have been sending in fillers. They are very much appreciated. I hope I will be able to supply similar material for "73 Junior."

Would 73 be interested in a short article on the subject of how semiconductor grade silicon is produced?

Bill Turner
Five Chestnut Court
Saint Peters, Missouri 63376

No . . .ed.

Dear Sir:

We thought it may be of interest that there is a new net on the air for emergencies and DX contacts. The world DX Round Table operating on 14270 KC Wednesday and Saturday from 0500-0800 GMT.

All QSL's for net contacts may be forwarded to (WA5UHR) net QSL manager.

Scott Freile
1510 Lynnview
Houston, Texas 77055

Dear OM Wayne,

I was given "DX-Handbook" first-edition from my good friend WA9NKG, "Paul" & find it a very nice book, especially I enjoyed the article about 80 meters DX. Here in JA, there are not so many DX's on 80 meters, only JA6AK is active. Hi. By the way I found some misunderstanding on page 90, "Call Areas." Please correct as follows:

JAPAN	Wrong		Right
JA1	Kanto, Shinetsu	JA1	Kanto
JA2	Tokai, Hokuriku	JA2	Tokai
JA9	Fukui, Toyama, Kanazawa, Ishikawa	JA9	Hokuriku
JAØ	Nagano, Suwa, Niigata	JAØ	Shinetsu

JA9 includes three prefectures; Fukui, Toyama, & Ishikawa, and Kanazawa is capital city of Ishikawa, like Phoenix in Ariz! JAØ has two prefectures; Nagano & Niigata, and Suwa is the name of one city in Nagano!

About 7 or 9 years ago in JA, there were only 8 areas from JA1 to JA8, and then JA1 & JA2 were divided into two till then JA1 had Kanto & Shinetsu, JA2 had Tokai & Hokuriku, but since then Shinetsu changed to JAØ & Hokuriku got JA9 calls, so you might use the old date! Hi! Anyway now you are all right!

Another info here, you wrote "for DX Watch for gigantic do-it-yourself coloring map," on 22 page. We can buy do-it-yourself map for DX from our JARL. About 55x80 cm ¥ 200 (about 60¢) with great circle map. This map is very nice for DX hound! You may get the map if you send about $1 to JARL, P. O. Box 377, Tokyo.

Oh, one more info, JA1 area got too many hams and they needed another call so they used JH1. It was two or three years ago. And now JH1 also going away the newest call right now (29 June '69) is JH1VZZ and JH1Y . . . JH1Z . . . is used for club stations so the rest is JH1WAA to JH1XZZ, when all of these calls used, they use JR1. First JR1 will go on the air in '69!

Narumi Kawai, JA9APS
1-10 Suwanokawara
Toyama-City 183, Japan

Dear Wayne,

I read with interest the article on facsimile and the radio amateur by Ralph Steinburg K6GKX in June, 1969. (I also had an article starting on page 130.)

You should know that facsimile and slow scan TV are exactly the same thing electrically if you add a horizontal sync pulse to the facsimile signal.

I have been running slow scan TV for the past 2½ years (one and a half years under the special slow scan TV license), using facsimile equipment. As far as I know, this is completely legal since I am conforming in every way to the various television kinds of signals that are being sent. Those who are receiving the slow scan TV signal using facsimile equipment can use the horizontal sync pulse if they wish. Those receiving the slow scan TV signals on a CRT presentation, generally require the sync pulse. Those that are receiving them on facsimile machines, do not need it.

Mr. Steinburg's statement, "with slow scan television legal on the low bands, facsimile may be the next mode of communications to follow in the near future. All it needs at the present time is enough interest by the radio amateurs to show the Federal Communications Commission, by petition, that facsimile will contribute to the state-of-the-art," really impedes matters by continuing the fiction that there is a difference between facsimile and slow scan TV.

J. R. Popkin-Clurman, W2BK
1623 Straight Path
Wyandanch, New York 11798

Dear Wayne,

Up until the past few months, very little effort had been made to attract youngsters into our ranks and it is indeed regretful that we have been so tardy in promoting amateur radio to this particular age group. Editorials in some of the amateur magazines have at last recognized the severe lack of youth-intake in amateur radio and soberly suggest that we make strong efforts to try and introduce these young people to ham radio.

Some may ask, "Why is youth so important to amateur radio?"

There are a multitude of good reasons why amateur radio needs new blood and certainly each reason has its own merits. To mention but two, we might start with what amateur radio as a hobby can provide for a youngster just getting started in ham radio. It offers a youngster the chance to convert his spare time from roaming the streets, lying idle on the couch, etc., to something constructive, educating, challenging and rewarding. For some, amateur radio can lead to a very successful career in electronics later in life. Amateur radio in the years to come, will need new amateurs to improve the state of the art and in general to man the helm. Todays youthful prospective amateurs will be the people to assume this task. This is why it is of cardinal importance that all amateurs do their utmost to familiarize the youth of today with ham radio.

Today's youth are basically a good group of people and they have a tremendous amount of potential and energy which if could be directed to the area of amateur radio, would lead to an eventual license and a genuine feeling of accomplishment and satisfaction.

Boy Scout Explorer posts, high school radio clubs, camps and other outlets have time after time graduated the prospective young amateur from training in code and theory, to an amateur license. However, these organizations lack the ability to make the initial contact with a youngster and this is where the individual amateur must help out.

One may ask at this point, "Well, what can I do?"

Get in touch with the youngster down the street and invite him or her over to the shack. Fire up the rig and explain how it works. Show them your collection of qsl's–let them have a try at the mike–show them what an amateur license looks like–be patient and encourage them, and most of all, let them know that you sincerely want to help them. You might then direct them to a local radio club or some other group that teaches code and theory classes for future hams. If there isn't any such group in the area, then you, yourself, could certainly help these young people. Five wpm and elementary theory and regulatory material certainly isn't difficult to teach to eager students, is it? They will always admire you for your guidance and assistance, believe me.

While amateur equipment becomes more and more sophisticated, and with DXpeditions and contests taking up a substantial amount of our hamming time amongst other facets of amateur radio, let us not neglect the youth around us for they certainly hold a share in ham radio's future.

The initiative is up to you. Ham radio is a very fascinating and rewarding hobby and has so very much to offer. Why not get in touch with the youngster down the road and lend the helping hand they need and at the same time, strike a blow for amateur radio.

Ralph J. Irace, Jr., WA1GEK

Dear Wayne,

Thanks for the articles by K1YSD. Many moons have passed since I laughed so hard. As a result of your fine articles on the Advanced Class License I passed my test.

Tom Shirley, K4HVV
410 Patton Road
Hinesville, GA 31313

Dear Editor,

Would any members of the American Cryptogram Association who are readers of "73" drop a line to the writer? The intent is to form a net to discuss crypto systems and solutions.

Thank you.

Herbert S. Dunkerley, WA3JIX
RFD 2
Jeannette, PA 15644

Dear Wayne,

I have finally rounded up a bunch of information on the recent beginners course in ham radio and a photograph of some of the instructors and graduates. Only 17 of the 28 who received a novice ticket are on the picture, but that was the best that I could do.

As for the course, here are the bare facts: Enrolled–109, Attended 6 or more lessons–48, Attended less than 6 lessons–61, Quit after attending 6 or more lessons–15, Earned Novice ticket–28, Attended whole course but not passing exam–5, Oldest earning ticket–69 years, Youngest earning ticket–13 years.

The course ran for 16 weeks. There was one hour of lecture on theory and one hour of code instruction each week. The first eight or nine lectures were on basic radio theory and regulations, and the last seven or eight were on specific topics: antennas, transmitters, power supplys, etc. Most of the basic theory was taught by Charlie DePoe, WA5VQR, a professor at the local college, who also kept the vital statistics throughout the course. The specific topics were taught by various members of The Twin City Hams radio club, some of whom are in the enclosed photo.

I taught the code portion of the course. It was designed for the beginner and started at zero wpm. At the end of the course, the average speed of those finishing was about 7½ wpm, with a couple of the fast learners copying around 15. The code practice was recorded on magnetic tape prior to each

Recent FCC News

RM-886. The ARRL has requested that the CW-only band on two meters be moved from the high end of the band to the low end, 144.0 – 144.1 mhz. It has been the custom to use only CW in this lower 100 khz of the band, however, it may be worthwhile to make this into law if there are too many operators that refuse to honor the convention. It seems a shame that we have to make federal laws just to force a few inconsiderate operators to conform to custom.

RM-950. The ARRL has requested the opening of 28.0 – 28.5 mhz for F1 emission. This is RTTY which is now restricted to the CW portions of 80-40-20-15 meters. It should have been allocated that way in the first place. It is nice to see the ARRL behind this request . . . they were the principle opposers to the original requests for F1 on the low bands and managed to delay the FCC ruling on this for several years.

RM-981. A petition has been filed with the FCC to open all bands from two through 80 meters to maritime mobile while in Region 2 and to open 3.5 – 3.8 and 7.0 – 7.1 mhz for maritime outside of Region 2. At present maritime ops are permitted to use 40 thru 2 meters in Region 2 and 20-15-10 meters outside Region 2. Seems reasonable enough.

RENEWAL CODE

The two numbers under your call on the address label are the expiration code. We have tried to make it simple. The first number is the month that we send you the last copy on your subscription and the second number is the year. 78 would be July 1968, for example.

session to keep sending errors and resulting confusion to a minimum.

Everyone in the club agrees that the course was an unqualified success and that we all learned a great deal from it. It is still hard to believe that so many people are interested in amateur radio and are just looking for a chance to get into it. Any club can do itself a lot of good by encouraging people with a genuine interest.

Now, can anyone tell me how to keep 28 brand new Novices on the air?

Bill Gulledge, K5UAR
700A Plum Street
Monroe, LA 71201

Dear Wayne,

Since working as Chief Engineer of KALX (FM), my perspective on the Amateur license technical examination has changed. Many people will agree that it is a simple and uncomplicated task to pass the technical section. But in comparison with the First Phone exam, it is hardly a test at all.

You might note that the Amateur license is just that: for amateurs. But what has this done to the quality of the average ham? One can simply listen to the low bands any evening to provide the answer.

The degradation in quality has been brought about through the lack of respect in the ham license. Years ago it took real perseverance and intelligence to be a ham operator. There were no readily available stations, as today. Kits, if any, were almost the same as building from scratch. And when the ham was finished with a piece of gear, a receiver perhaps, he had a sense of pride, a sense of accomplishment. Today, the closest thing to that most hams experience is the sense of relief one feels when the last payment is made on a complete transceiver. Too, there was a feeling of fraternity. There was belonging, brought about because there was a great hurdle that everyonr had to pass to become a ham: the building of a transmitter and receiver, and the exam.

Today the exam is not difficult. And today the only comradeship most hams feel is in their mutual animosity towards CB'ers. Little wonder that the bands should be in such poor shape. When one loses respect in something, one is not apt to take good care of it.

One good way to make an Amateur license more valued is to require a stiff technical exam, one that would require actual studying, not memorization sessions with the License Manual. But the more difficult technical skills it engenders would prove greatly beneficial to the ham, and the country. It might even save the Amateur Radio Service.

I'd like to hear your comments on my letter.

Stephen L. Diamond, Radio KALX
500 Eshleman Hall
Berkeley, California 94720

Caveat Emptor?

★ Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

★ Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.

★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

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SPECIAL CLOSE-OUT SALE. Rectifiers, Transistors, and many other Electronic Parts. Lowest prices. Send 15¢ for Catalog. Electronic Components Company, P.O.Box 2902 S., Baton Rouge, La.

3 PLASTIC HOLDERS will frame and protect 60 cards, $1—or 10 holders $3. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, Tennessee 37066.

WANTED ANTIQUE RADIO and wireless equipment. Also radio magazines of teens and twenties. Also buying supply catalogs, Duck, Manhattan! etc. Farrell, 2252 Dixie Pontiac, Mich. 48055.

THE ANNUAL HAMFEST for the Washington DC metropolitan area, sponsored by the Foundation For Amateur Radio, will be held at the Gaithersburg Fairgrounds in nearby Gaithersburg, Maryland on Sunday September 21st, from 1000 until 1700.

RTTY GEAR FOR SALE. List issued monthiy, 88 or 44 mhy torroids 5 for $2.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

"TOWER HEADQUARTERS!" 11 Brands! Heights aluminum 35% off! Strato Crank-ups-low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog-20¢ postage. Brownville Sales Co. Stanley, Wisconsin 54768.

TECH MANUALS, and service data for Surplus Electronics. Thousands of publications on hand, covering communication and test equipment. Sorry—no catalogs, but will rush price and availability quotes for specific literature that you may need. Propagation Products Co., Box 242, Monroe Street Post Office, Jacksonville 1, Florida.

OHIO VALLEY 6 meter phone net 50.350 every Sunday. 2000 EDT, WA8WIW, NCS Sciotoville, Ohio. Traffic and Rag Chewers Welcome.

FIND OUT about the New Greene Balun. Read all the details on page 59 of this issue. Greene Balun, Warfield, R.I. o2880

WANTED: TECHNICAL material. Corp model XFK freq. shift exciter for Tmc model GPT 750—also TMC single sideband exciter, model SBE for GPT 750 & manuals—plus 18 to 30 foot parabolic dish. What will you take for it in place of money—will swap brand new towers or test equipment. Write, wire or call: Eugene Leger, Hollis St., East Pepperell, Mass. 01437.

SELL: COLLINS KWS-1, Ser. 896, $640; 75A4, Ser. 5763, $420—or both for $1025. I will ship. Lew Hindert, Rt. 4, Box 290, New Braunfels, Texas 78130.

WANTED: CR tube for Tektronix 561 or 561A oscilloscope. Sell: Collins CC-2 Carrying Case, $50.00; TMC Commercial TTG-1 two-tone oscillator, $95.00; Kepco SC-18-4M transistorized power supply, 0-18 VDC, 0-4 amps, 0.1% regulation, metered, $110.00; Bird 6254 R-F watt meter, 0-2 watts, 30-500 mc, 50 ohms, $50.00; Bird 67 R-F watt meter, 0-25/100/500 watts, 30-500 mc, 50 ohms, $125.00. FOB, H. T. Cervantes, 34 Johnson Rd., Binghamton, N. Y. 13905 (607-724-5785).

CHRISTIAN Ham Fellowship now organized for Christian fellowship and gospel tract efforts among Christian licensed amateurs. Christian Ham Callbook, $1.00 donation. For details and sample copy of ham gospel tract, write to Christian Ham Fellowship, P. O. Box 218, Holland, Michigan 49423.

WANTED TEST EQUIPMENT: Bird watt meter, measurements of G. R. sig. gen. up to 450 mc; Tektronix scope. State price. W2EDN, 93 Gilmore Ave., Binghamton, N. Y. 13901.

WRL'S USED gear has trial-terms-guarantee! KWM1-$249.95; HW32-$89.95; Swan 250-$249.95; TR3-$369.95; NCX3-$169.95;SB34-$299.95; Galaxy V-$229.95; Galaxy Vmk2-$279.95; Ranger-$99.95; HT32A-$259.95; 100V-$259.95; Galaxy 2000 linear-$329.95. Many more. Free "blue-book" list. WRL, Box 919, Council Bluffs, Iowa 51501.

WANTED: Turret Turner with coils or old chassis with Turner for Hammarlund SP400X receiver. Later model with 13 plate stator & 14 plate rotor. Ralph M. Williams, Box 372, Dixfield, ME 04224.

SELL HALLICRAFTERS HT-32 Transmitter, excellent condition inside & out, $210. Will deliver within 50 miles. Want Collins 32S1 or 32S3. Robert Kujawski, WA2VDX, 30 Rose St., Florida, N. Y. 914-651-7212.

GREENE . . center dipole insulator with . . or . . without balun . . see September 73 issue.

HAMS WHO LIKE audio, too, try new quarterly: Amplifiers by Williamson and Bailey, speaker by Baxandall. Details, Audion 307 Dickinson Ave., Swarthmore, PA 19081.

CINCY STAG HAMFEST: The 32nd Annual Stag Hamfest will be held September 28, 1969 at Stricker's Grove, Compton Road, Mt. Healthy, Cincinnati, Ohio. Door prizes each hour, raffle, lots of food, flea market, model aircraft flying, and contests. Identify Mr. Hamfest and win prize. $5.00 cost covers everything. For further info., contact John Bruning, W8DSR, 6307 Fairhurst Ave., Cincinnati, Ohio 45213.

Increase Your Grid Dipper Range

There is general agreement that a grid dip meter is an invaluable piece of amateur test equipment. Why then confine its use to the usual frequency range of 2 or 3 mhz to perhaps 250 mhz when it is some easy to make additional coils to cover the lower ranges?

Browsing through the catalogs will quickly convince you that hardly anyone sees fit to supply low frequency coils and when they do it is at additional cost. Why not make your own? All that is necessary is a base which will fit the coil socket of your dipper, a coil form or two, and a little patience. My current dipper is a Heath GD-1 (which I find superior to several others I have had around the shack) which requires a two-pin coil base. In my case I had only to bend two lengths of copper tubing to the proper spacing for the coil terminals at one end and the socket spacing at the other. After the proper frequency range was established, the entire coil and about a half inch of the leads were potted in casting plastic, making a very sturdy assembly.

The low cost coils I used (5 cents each at a local hamfest) came equipped with a ferrite slug. I left the slug in for the lowest range – 250 khz to 1 mhz and took it out of the higher range – 1 mhz to 2 mhz. No exact data can be given due to the variation in dipper circuitry. This will be a case of pure "cut and try." The range of the new coils must be plotted on a graph against the original dial markings.

A general coverage receiver will allow calibration down to 550 khz and by feeding the signal into its *if* strip, an additional point at approximately 450 khz is obtained. Below that frequency things get a little tougher. If you happen to have a low frequency receiver, fine, if not, use harmonics in the BC band.

William P. Turner, WAØABI

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73 MAGAZINE
PETERBOROUGH, NEW HAMPSHIRE 03458

73 Magazine #109, October 1969

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Gravity Waves
Solution to Vietnam?
Making Extra Money
Making $1,000,000!
Reactionaries
Marathon Nets
FCC Actions

...de W2NSD/1

Wayne Green

Gravity Waves

My thanks to old friend Neil W2OLU for sending in a clipping from the New York Times announcing that Professor Weber of the University of Maryland has detected gravitation waves. The existence of gravitational radiation is predicted by Einstein's General Theory of Relativity and Professor Weber believes that he has experimentally verified Einstein's prediction.

A century ago Maxwell predicted from mathematical calculations that there were other types of electro-magnetic radiation than light rays. In 1888 Hertz confirmed Maxwell's predictions and opened the radio spectrum.

As I mentioned a few months ago, here is a field that is wide open for the amateur. There are no professionals in the field yet. What, all of us want to know, is the velocity of propagation of a gravity wave? Speed of light? Instantaneous? If it is faster then it would make a wonderful communication medium for interstellar contacts . . . and might explain how those pesky UFO's are able to get here from planetary systems so far away that reputable scientists say that they cannot exist just because there is no possible way for them to come that distance.

If you have any info to pass along on gravity generators or detectors, let's pass it along through 73.

Vietnam Solution?

The educated opinion seems to be that President Nixon has been hoping that he could use the same route for settling the war that Eisenhower used for closing out the Korean conflict. That meant working through Moscow, who, because of the Chinese difficulties, were supposed to be anxious to accomodate the U.S.

This approach doesn't seem to have worked out in practice at all, a situation which leaves us still boiling in our own kettle of soup. Unilateral disengagement means, essentially, the slaughter of most of South Vietnam, the historic consequence of losing a war in Asia. This, in turn, can hardly help the non-communist forces in Laos, Thailand, Cambodia, Malaysia, Burma and India. Any promises we have made in the past of help will hardly be honored after the disaster in Vietnam, and they know this.

Obviously, getting out of Vietnam unilaterally is a very bad solution to our problems. Should we then turn around and escalate again? We have seen that the communists are able to match every escalation. They have no intention whatever of losing the war. They have been at it for many years there and are not about to drop it now.

This is a subject that can better be argued in a book-length form than a brief editorial comment such as this, however I would like to make an abbreviated suggestion for a new course of action that might possibly prove more rewarding. I wrote about this a couple years ago upon my return from Asia, but not much came of it. The ideas still seem quite valid . . . perhaps even more valid than ever, since more options have been tried in the meanwhile without noticeable success.

Basically, I propose that the Pentagon and the State Departments do not have a corner on the U.S. brain market. Experience has rather indicated negatively in this respect. Possibly then, we could do better than depend upon them for our total effort in Vietnam, directing the fighting and peace talks, which about sums up our activities there.

Just suppose that we decided to fight a much more basic fight, using our biggest weapon? The bomb? No, not at all. The battle between communism and capitalism is

most fundamental. Why not use capitalism as a weapon? This is one weapon that has been almost irrestible so far and yet we have made little effort to use it.

For a fraction of the $100 million a day we are spending in Vietnam we could ship production machinery from the U.S. to set up factories around Vietnam. I envision a change from the present agricultural system to a half agricultural, half industrial system, with factories spread out so that workers can continue to farm part time. I wonder if this isn't a happier way of living than our all-or-nothing arrangement?

Factories in undeveloped countries are rather basic affairs and far less expensive than those in our country. With a relatively small investment we could spread factories all over Vietnam, providing jobs part time in hundreds of villages. Would the people make the change? If the incentive is there, they will. The incentive that I have seen change one country after another into industrial countries has been the availability of inexpensive cars and television sets. People will work incredibly hard for these pleasures.

Suppose we set up a few dozen factories making prefab huts and basic furniture and gave these products to the Vietnamese, along with a small plot of land for a garden? Not only would we be able to clean up the miserable camps now housing thousands of refugees, but we would also have something very interesting to offer defectors from the North. Cars, TV, and other luxuries would have to be earned.

The whole bill for a give-away program like that might come to $1000 per defector, but that is a small fraction of what we are paying right now to try and kill them as they come down to fight. It is costing us some 500 times that much!

Once we convert Vietnam to a capitalistic system, they will be forever broken away from the old patterns and can soon take their place among those Asian countries who have made the change ... Singapore ... Thailand ... Japan. There are plenty of markets in Asia for products manufactured in Vietnam since few of the neighboring countries are developed.

Does that sound better than the alternatives of fight harder or quit?

Danger

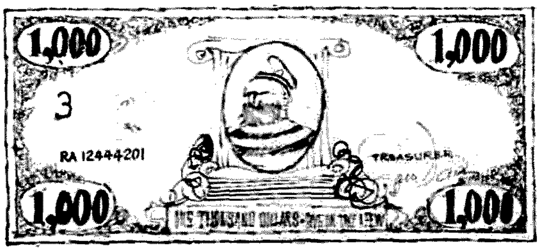
As those of you who know me personally know, I love to eat and as a result I am generally a bit on the heavy side. Every couple of years or so I go on a diet and take off the accumulated layer. This summer, egged on by the wonders of the Doctor's Diet, a lovely invention wherein you eat meat and drink water. . .and not much else, I decided to make the plunge. The book said that I could also drink all of the diet soda I wanted along with the diet, so I loaded up on my favorite flavors of "tonic," as they call it up here in New Hampshire, all sugar free.

Fat free beef and fat free chicken left me with plenty of hunger pangs, but the diet soda filled up the empty spaces and I found that I was drinking more and more each day, getting up to some four bottles a day. No harm done, so why not?

Along about the third day I began to find it difficult to focus my eyes and I started having periods of vertigo. This got progressively worse and by the seventh day I couldn't even see to type, much less read manuscripts and proof-read articles. My eyes just couldn't focus any more at all. I realized that meat certainly wouldn't do this to me, and since the only other thing I was eating was diet soda, it obviously had to be that. I stopped.

Within a couple of days the headaches stopped, the vertigo stopped and my eyesight began to improve. After a week I could read medium-sized print again and type.

The secret was right there on each bottle, if I had taken the time to read the fine print while my eyes were still working. That stuff is supposed to be only for people who have been requested by a doctor to restrict their intake of sugar . . . diabetics. In moderation I suppose it would not cause noticeable difficulty. Who would notice his eyes slowly deteriorating over a period of weeks or months and tie it in with diet soda? Even occasional headaches and vertigo might not be suspected. And who knows what other damage these beverages may be doing? They certainly must be able to have a profound effect on the human body to be able to do me in so quickly on such a small dose.



Extra Income

When people explain to me that they are too short of money to buy a subscription to 73 I look at them in wonder. Short of money! That is truly remarkable in this day when there are so many simple ways of making money in spare time. The money is there for those that are willing to go after it.

There are so many things to sell and so many services to offer that there should be something for everybody. If you live in an area where you can make unlimited local phone calls at no extra charge, you have a goldmine. You can sell products or services over the phone.

Take for instance selling magazine subscriptions. Most families buy at least one magazine subscription and some buy as many as a hundred a year. Why should all these people buy their subscriptions directly from the magazines when they could just as well buy them through you and save money for themselves?

How do you get started in something like this? Well, first I would write letters to the circulation managers of the larger circulation magazines on some quickly made letterhead. If letterhead costs too much, make your own with a rubber stamp on blank paper. You can be in business for about $2 as the Amalgamated Subscription Agency. You can find the magazine office addresses on the magazine masthead at your local newsstand.

Once you have some of those juicy subscription agent prices in hand you can start calling people right out of the phone book and quote them a price on buying a new subscription or extending their current subscription to Life, McCalls, Reader's Digest, etc. Once you get them for a customer you naturally keep track of their subscriptions and give them a call when renewal time comes along. Ask them for a list of the magazines they read and write to the other publishers too. Before long you will be an agent for hundreds of publishers.

You can find out about special interests locally too. Just as you can get a list of customers from a radio parts store which will help you sell radio magazines, also you can get names from a sporting goods store for selling sporting magazines, from a camera store to sell photography magazines, and from the sports car garage to sell car magazines. You can build up lists of dozens of special interests for magazine sales.

Do I have any other money-making ideas? Sure, plenty. You're interested in electronics, so how about selling some electronic equipment? Have you ever thought about selling closed circuit television installations in your area? Many businesses and even homes are excellent sales prospects for them. Or how about selling one of those radar alarm systems to the store owners locally?

There are thousands of things to sell. You can sell direct from your home, over the phone, or even act as a manufacturer's representative to sell items to local retail stores. The magazine Salesmen's Opportunity lists more products looking for salesmen than you can imagine. The Macfadden .50 book on *How To Make A Fast Buck* will give you hundreds of more ideas. Most of the companies that do public surveys are in need of help from the hinterlands and the pay is sometimes surprising.

One of the biggest skin diving stores in the country sprang from a small bedroom in the wilds of Brooklyn. The enterprising high school student rubber stamped up some letterhead and became a dealer for several manufacturers. Low overhead meant bargains for the customers and before long his parents were being crowded out of the house. Stop in and say hello to Harvey for me the next time you visit Sheepshead Bay.

One of the biggest ham radio distributors in the country started out not many years ago in a little corner of his father's furniture store. Does that give you any ideas?

Wealth?

A few months back there was a very snide reference in one of the other ham magazines to a little booklet I wrote a couple years or so back on *How To Make a $1,000,000.* I've

mentioned this briefly in my editorials before, I realize, explaining that my interest in the matter is more academic than real.

This academic interest does lead me to read most of the books that come out on the subject of making money or keeping it, once you've made it. And that can be a problem too. In addition to the book by Lloyd Colvin W6KG on making a million in the home construction business, I might also recommend the pocket books on *The Rich and The Super Rich,* and *Atlas Shrugged.* The first of these was particularly interesting to me because it backed up my own deduction that college education not only does not help you to make big money, it in fact is a severe hindrance.

Fortunately for our school system very few people seem to be even slightly interested in going for the big money. By big money I mean enough to permit you to retire and live comfortably from the invested capital, not millions of dollars.

Fortunes are not being *made* any more, just inherited. However, thanks to inflation, it is not at all difficult to gather together one little bitty million. This is being done quite frequently by those either shrewd enough to figure out the system or those lucky enough to fall into it. I suppose I should add a third group that ignore the system and get there by stealing.

Even considering Parkinson's Second Law (expenses will always rise to meet income), $1 million dollars invested at a mere 5% should last you rather well. You won't be a big yacht customer or buy a Rolls, but at $50,000 per year the wife shouldn't have to buy cloth coats for winter.

Naturally I recognize that the preponderance of 73's readers are inescapably committed to their present life and that any discussion of a career is, for them, quite academic. On the other hand, few of us are not occasionally put in the position of being able to influence a younger person, so perhaps a bit of thinking about careers and the future is not entirely out of line.

It is all too easy to try to pass along the values that we have been taught. I accepted without hesitation the idea that everyone that could should go through college. It never even occurred to me to question this. I think I have the matter in better perspective now.

A college education, complete with Master's degree, is worth every dollar and day to the fellow who wants to work for a large company for the rest of his life. The pay is good and the life is American Standard. Of course it means buying most of the big things on time payments for many, many years. The house will never be paid for, since advancement in business means moving into a bigger house every few years with attendant refinancing. Add car payments, boat payments, vacation payments, etc..

That little postcard from Cleveland Institute that we bind into 73 every now and then got me to thinking. I detest those darned things, but as a publisher I have to recognize the economics of my business and run them now and then. At any rate, I sent in one to Cleveland and in a few days one of their nice four color brochures arrived. The cover letter asked me, "Where do you want to be in life in one year . . . in two years . . . in three years from now?

My own plans are formulated, but I wonder how many of the younger amateurs have done much thinking about their future?

There are, obviously, many fortunes to be made in electronics. It is one of the fastest growing fields in the world today. This means opportunity. The big corporations will get bigger, naturally, but thousands of little companies will blossom out and make small fortunes for their entrepreneurs. The little booklet that I wrote on making a million dollars explains a very simple method of taking advantage of this growth, starting out with nothing and getting over the hump in a very few years.

One does not become a successful businessman by starting his own business any more than a concert pianist succeeds by going on stage with no experience whatever. Success requires a lot of hard work and luck. And the harder you work the luckier you get.

Something else has changed with the generations too, I suspect. It may be my own special background, but in my youth it was not looked down on as a goal to work for wealth. Now, when talking with teen-

continued on page 126

A Super-Gain Antenna for 40 Meters

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This article gives briefly the results of a study to develop an antenna for the 40 meter band which would allow the hams to compete somewhat better with the foreign broadcast stations which practically take over the band in the evening and nighttime. In this respect the study was a partial success in that an antenna was developed based on the theory of super gain arrays, which rejects QRM from low angles. After some experimental work, a super gain antenna[1] was designed for the 40 meter band which is extremely simple, uncritical and offers large gain and QRM rejection factors.

The propagation studies and design work for this antenna were done at Dusina Enterprises in Melbourne, Florida.

Briefly, the antenna to be described has a forward gain of approximately 9 DB based upon engineering design data developed in the literature[2] and in addition to the forward gain has an average of 15 DB rejection against low angle QRM. Therefore, two hams both using this type of antenna array can gain an advantage of about 14 DB[3] improvement in signal strength and about 15 DB less QRM when communicating via high angle paths over short skip distances for an overall S/N improvement of about 29 DB. Short skip distances on the 40 meter band mean up to about 200 miles radial distance from the transmitter in the daytime and up to about 1,000 miles in the nighttime. These distances are selected from actual performance measurements on the array to be described.

The antenna is of the super gain class and consists of a single dipole antenna placed very close to and above a reflecting screen such as to limit the radiation to 90 degrees plus or minus 35 degrees approximately. The antenna is made in a very simple manner as follows. A 300 ohm TV type twin lead folded dipole is cut to the length 63 feet 2 inches plus or minus 1 inch and is fed in the center with RG 58 U coax or some other 50 ohm coaxial cable. This folded dipole antenna is suspended tautly seven feet above flat ground using three wooden poles or some other suitable support. If metallic poles are used, it is suggested that nylon cord be used for approximately three or four feet between the ends of the antenna and the metal pole so as to reduce the effect of capacitance on the ends of the antenna. On the ground directly below this antenna are laid three reflecting wires of a noncritical length sixty-five to eighty feet long. One wire is stretched along the ground directly below the antenna element. One of the remaining wires is laid along the ground parallel to the antenna but approximately six feet from the wire directly beneath the antenna. The third reflecting wire is placed on the other side of the antenna such that when the reflecting screen is completed there are three wires six feet apart, one under the antenna and one on each side forming a reflecting screen about eighty feet long by twelve feet wide. These reflecting wires are laid on top of the ground but they may be in the ground if desired. A slightly higher efficiency will result if they are placed on top of the ground, and the method used here over a lawn was to cut the lawn very low and lay the wires on top of the grass. When the grass grows back out, the wires will stay under the turf and not be

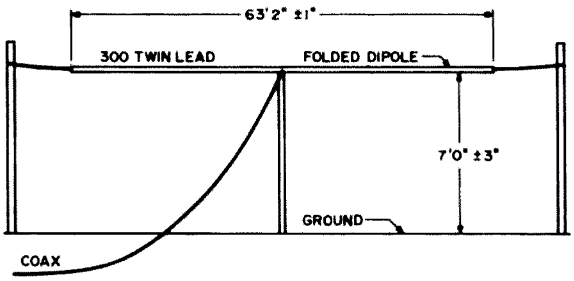

Fig. 1. Super-gain 40 meter skywire.

bothersome. The ends may be wrapped around large nails and the nails driven into the ground to assure that the reflectors do not curl up on the ends. Any reflector wire size larger than about No. 26 will be adequate, and larger than No. 14 is being wasteful.

As can be seem from the foregoing description, this antenna is sufficiently simple that every radio amateur can construct one. Although this antenna is intended to be used mostly for short-range communications up to about 200 miles, due to the nature of the 40 meter band, short skip conditions prevail much of the time at night and the antenna is then effective for distances of 1,000 miles and sometimes more with full gain.

An antenna constructed in accordance with the directions given above yields the following VSWR when fed with a 50 ohm coaxial cable. The antenna measured was fed by 100 feet RG-58 cable, used No. 26 wire reflectors and was tested at 2,000 W PEP:

FREQ	7.0	7.1	7.2	7.25	7.3	7.4
VSWR	3.6	2.6	1.3	1.05	1.5	3.0

Propagation Effects

Tests conducted in Florida on the effectiveness of this antenna in improving communications capabilities on the 40 meter band revealed significant improvement of an amount unexpected before the tests were made. These tests revealed the following characteristics:

Daytime Use

Typical daytime results comparing the super gain antenna to a two element collinear array with 2 DB[4] gain and elevated sixty feet above the ground (maximum radiation at 35° elevation) gave the following comparisons.

Stations from Alabama received at Melbourne, Florida, were typically 10 DB stronger on the 60 foot antenna than they were on the super gain array. This communication was at a distance of about 500 miles, which is long skip (about 35° arrival angle) for daytime 40 meter conditions. At approximately the same time, stations in North Carolina, a distance of about 700 miles, were 6 DB stronger on the high antenna than on the super gain array, while stations in Tennessee, approximately 700 miles distance,

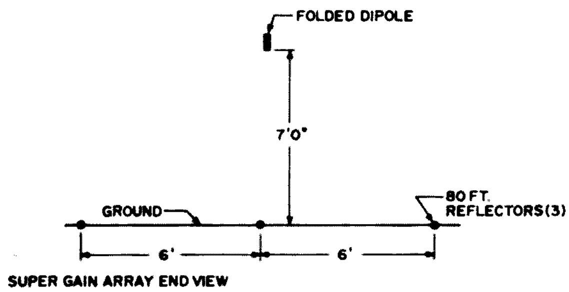

Fig. 2. Super gain array end view.

were 6 DB stronger on the high antenna than on the super gain array. The rejection drop to 6 DB from 700 mile distant stations was due to the loss of gain in the collinear at the 25° arrival angle and not due to improved pickup on the super gain array at the lower angles. These data show that the super gain array does in fact discriminate against signals arriving at the lower elevation angles. Comparison checks, made at the same time, on stations transmitting from sites in Florida revealed that signals originating within 80 miles of the super gain array were approximately 15 DB stronger and stations within 200 miles were 10 to 12 DB stronger on the super gain array than on the collinear array at 60 feet altitude. In general, in the daytime a very marked increase in received signal level is apparent on any station within approximately 200 miles of the super gain array, and the most noticeable aspect is that signals that are received on the super gain array are much more free from QRM, whereas on the other antenna noticeable QRM, or even difficult copy, may be present. This is a result of the combination effect of the super gain antenna 9 DB gain plus its 10 to 15 DB rejection capability for low angle QRM. The 15 to 25 DB improvement in signal to QRM is very obvious.

Nighttime performance

In general, the super gain array gives approximately 10 DB rejection against the foreign broadcast stations much of the time but some of the time, due to the nature of the 40 meter band, these long distance signals arrive over many, many hops and come down within the vertical acceptance angle of the super gain array. At these times, there is little significant difference between broadcast interference received on the high collinear or the super gain array, but the

super gain still boosts the transmitted signal greatly. At other times, when short skip is not predominating, there is a marked reduction in QRM as well as increase in signal strength by the use of the super gain array for communications out to a distance of approximately 1,000 miles at night. Under these conditions, the strength for signals originating within 1,000 miles is boosted similar to that experienced over 200 mile daytime paths.

Most persons who have worked with array antennas on the high frequencies are aware of the fact that it is difficult to get a sizeable change in S-meter level between a reference antenna and even moderate sized array. However, the results obtained with the super gain array are striking in that the S-meter moves appreciably, usually at least one and sometimes two S-units in actual signal level, and if the QRM level will be noticed in the quiet periods of the transmitting station, it will be found to drop from 3 to 5 S-units when using the super gain array. If the QRM is of low angle origin, our experience has been that this antenna frequently changes a QSO from barely readable to armchair quality.

Due to the extreme simplicity of this antenna and to its significant improvement in communications on this particular band, plus its small size, I believe that if amateurs erect such an antenna and test it for themselves, they will be quick to see the value of it and by this means more use can be obtained from the 40 meter band. Particularly, this antenna would be an ideal antenna for local nets or statewide nets operating in the 40 meter band in the daytime, since it not only greatly increases the signal strength of the stations communicating, but significantly reduces the QRM leaving the state and rejects any QRM coming in from outside the state.

For those amateurs wishing to study further on the subject of super gain antennas and the types of gain that may be obtained, perhaps the most understandable and clearly-written dissertation is to be found in "Electronic and Radio Engineering" by Terman, fourth edition. Discussions on pages 903 through 908 cover the subject briefly and references are given there no more theoretical work should one desire to dig deeper.

Many amateurs have from time to time used very low dipole antennas on the 40 and 80 meter bands and some have remarked that these antennas do not perform as poorly as they would expect based on the low height. These results, however, have been erratic because the effect achieved is greatly dependent upon the conductivity of the ground under the antenna, and no compensation was made for the drastic change in radiation resistance or the change in effective length for such low antennas. The directivity gain of the very low antenna, which can be up to eight times in signal power, is frequently attained, in part, in these low installations over moderately conducting ground. However, the counteracting loss in antenna efficiency suffered, unless a reflecting screen is placed under the antenna to control the enormous losses in the ground, the variable reflection distance and low radiation resistance make the overall results highly variable from one installation to another.

The use of the reflecting screen is very important for three reasons. First, the antenna impedance will be 50 ohms only when the elements are cut as described above with reflecting elements installed. Without the reflecting elements this impedance can vary significantly. Secondly, the efficiency of drop well below 50 percent in most installations without this reflecting screen. This means that the overall gain of the antenna may be anywhere from zero gain, or perhaps even a loss, to a full 9 DB gain, depending upon the peculiarities of the soil under the antenna. Thirdly, without the screen the spacing between antenna and image is unknown and unstable, varying with ground conditions. Due to the utter simplicity of the reflecting screen, it is not worth the risk to omit it. Also, the effective length of the antenna varies with ground conductivity without the screen, so design becomes a cut and try affair.

It is hoped that other amateurs will erect similar antennas and run comparative tests on 40 meters as well as 80 meters and 160 meters. The 80 meter band performance of the super gain array has not been explored

yet so that the relative percentage of the time during which short skip conditions prevail, and therefore the magnitude of improvement possible, is unknown to me at this time, but will be published as soon as my tests are completed. However, those wishing to try such an antenna on 80 meters or 160 meters may scale the dimensions given, which is centered on 7250 khz, to obtain the design numbers. For those with lots of room, a group of these units operating broadside could generate a formidable signal indeed, but more than about four units would begin to restrict coverage noticeably. . . . W4NVK

[1] Patent disclosure filed.

[2] a. "Maximum Directivity of an Antenna," H. J. Riblet, Proc. IRE, 36 p 620, May, 1948.

b. T. T. Taylor, Proc. IRE, 26 p 1135, September, 1948.

c. "Physical Limitations of Directive Systems," L. J. Chu, J. Apl. Phys., 19 p 1163, December, 1948

d. "Directional Antennas," G. H. Brown, Proc. IRE, 25 p 122, January, 1937.

[3] This figure is referenced to a dipole, all others in this article are referenced to isotropic.

[4] Reference to dipole.

Printed Circuit Soldering Aid

Fixing printed circuits is really quite simple. Just clip out the defective component, leaving as much lead on the board as possible, and solder the new component to the old leads. This method works, and is recommended by many authorities. It does look like a butcher job though, doesn't it? A much better way which doesn't take much more time, considering the time spent locating the defective component, is to take it out completely. Usually the holes, whether printed through or eyelets, are plugged up with the old solder. Let it cool off; then quickly reheat and clean the holes with a piece of piano wire or stainless steel wire about .050 inch diameter. Solder will not stick to it, yet it can be formed and filed to a sharp edge at one end to aid in cleaning out the fringes of solder. A bit of masking tape makes a convenient handle if wrapped around the center portion of the tool.

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Kinnelon, New Jersey 07405

DX Corner

A number of letters have come in from WTW Certificate holders asking me to correct errors in the standings list published in March. While there isn't a lot that we can do about the list already published, every effort will be made to see that future boo-boos are kept to a minimum. Bear with me and I am sure that it will all be straightened out.

The cards that have been coming in show that 20 meters is still the favorite DX band. But there are signs of increased activity on the other bands. In the last few weeks I've been pleased to see that cards have been submitted for awards on two and even three bands. I realize that many of you are chasing that elusive 300 mark on 20, but you should do a bit of listening on others. The results may prove gratifying. You will find that a great many DX stations will be eager to make schedules for the other bands as well, for they are also interested in contacts on more than one band.

We have gotten used to thinking of DX in terms of 15-20 meters, principally. A common complaint goes something like this, "I listened for a couple of hours on 10 meters the other night and the band was completely dead. There's nothing doing there."

I'd like to suggest that you aim your antenna over the pole, about 345 degrees here in the East, and call CQ DX Pacific a few times. I don't want to make any rash predictions, but don't be surprised if you get answers from VR, JA, DU, XW8, VS6 and the like. It seems that a lot of people are listening at the same time without calling. So nobody answers!

I'd also like to encourage you to spend more time on 75-80 meters. There have been some very good openings lately, and wouldn't it be nice to hang a certificate on the wall for this band? How about it? In line with this I'd like to suggest that if you have not gotten your copy of the 73 DX Handbook, you do so at your earliest convenience. Concerning my mention of 80 meters, there is a tremendous article in the Handbook on just this subject by John Devoldere ON4UN. It is complete in every detail. John really went all out on this one. I am confident that anyone who reads and absorbs it will acquire valuable information that will assist in garnering many DX contacts on this band.

So I hope you will order this very important book soon. If you are interested in DX, I can assure you that it is the smartest three bucks you could spend, and worth many times the price.

I've been thinking—there are quite a few persons on the air who express anti-DX sentiments which often go unchallenged. There seems to be an idea going around that DX fever is an indication that somehow a ham is not a gentleman. It is a bit reminiscent of the attitude of some of my dry fly, purist angler friends toward bait fishermen.

This, of course, is arrant nonsense. My only reason for bringing it up at all is that I'd like some of these DX haters to try it for themselves, just once. Let them get into the competition for a piece of rare DX, overcoming their prejudice for just that brief recess, for just a taste of it. I'll warrant that a majority of them will be forced to concede that they've had the time of their lives.

It's hard to admit one basic truth. All types of operation may flourish and flower without adversely affecting the organic well-being of ham radio as a whole. There are some who express fear for the hobby's future unless everyone throws out his commercially built gear and builds his own. Silly, isn't it? Traffic men despise ragchewers. CW operators have contempt for phone men and vice versa. QRP enthusiasts loathe high powered boys. AM'ers call SSB'ers names,

and low band ops wouldn't spit on VHF'ers. And so it goes. The fact is, we all need each other, for the very life blood of ham radio is its broad diversification. We need all types of operations on all our frequencies.

Since DX occupies the hearts and minds of a large segment of our ham population, I believe it's wrong for non-enthusiasts to express violent opprobrium on the air, as though they were talking about lepers.

Many of our critics became sour on DX because they were not successful at it. They probably discovered that it was not as easy as they thought. Successful DX'ing is one of the most demanding facets of the game, calling for skill and patience, coupled with experience and maturity. It is not unusual to chase a specific country for years, and even then, there is no guarantee of getting it. I have been after a few of them for a long time, and I scrutinize the bands for them almost every time I sit down to operate. This is the only way I know; there is no royal road to success.

Many stations not engaged in DX chasing are operated in a fashion that would make the average DX'er cringe. They use mediocre antenna systems which simply could not cut the mustard. Their procedures would not begin to serve in DX'ing, for they still do not comprehend the importance of listening, listening, and listening some more. They are far too busy saying their "By Golly" and "Fine Business" for that.

But this is only one man's opinion. Don't take my word for it. If you want to get a taste of real excitement, put your signal and skill on the line, and get into one of the pile-ups sometime. You may become frustrated, that's for sure. But you will also find yourself developing a healthy respect for the skill and ability of the successful ones.

We all recall the story of the completely outfitted fisherman, with all the fancy tackle, encountering the kid with the buggy whip, dime store hook and can of worms. The urchin has no fancy flies, no two hundred buck rod, no waders, no nothing. But he has a stringer full of fish, and the fancy dude with the high class equipment hasn't a single trout. All the kid has is plain old talent, that's all! There's a lesson there for the would-be DX'ers.

Well, that's all I intend to say on the subject. If you are against DX'dom, and you have a feeling of superiority over the fools who participate in it, why, you go right ahead and do your rag-chewing or whatever. It will be your loss, I know.

* * * * *

I worked an odd one the other evening on 14 mhz CW. There was a huge pile-up on the low end calling LG5LG. He claimed to be operating from the Independent Territory of Morokulien, on the Norwegian-Swedish frontier. He gave his QSL address as LA4YF, and asked for three IRC's. Well, though I have a very suspicious nature, I have a standard procedure for cases that seem phoney. I work 'em first and ask questions afterward. So, I got the contact, hurdling the first obstacle.

I must admit to curiosity, so I began to investigate Morokulien. I consulted four of the best atlases ever printed, and there wasn't a trace of the place in any of them. By this time I was pretty certain it had been a counterfeit call, used by some joker, trying to have some fun and excitement for himself.

Later that night, however, I hooked up with a Swedish ham who told me that there really is such a place, and that LG5LG is a legitimate operation. He further informed me that the IRC's are redeemed, and the funds are turned over to a crippled children's hospital and therapy center. Needless to say, I sent my QSL out the next morning.

Both the SM and I agreed that it would be extremely unlikely that this LG5 would count for a new country, but today, when national boundaries and political status is in a constant state of flux, you can never tell. Incidentally, he also said that operations from Morokulien are very, very rare, so there is not likely to be another operation there in a long while. So, if you hear him, don't turn up your nose. Get the contact, just in case. What have you got to lose?

Gus has been making all sorts of stops in the Indian Ocean area, but so far there's been nothing that would add to anybody's totals, either for WTW or DXCC. It's pleasant to work Gus anyway, of course, but it would sure be nice to hear him from some rare one, Sikkim, Bhutan, Tibet or maybe

BY land. Speaking of rare ones, I'm preparing a questionaire for publication in the near future, which will aid in determining the priority ratings of wanted countries. We will then be in a position to assist DXpeditioners to plan their itineraries. It's not that we spurn a country simply because we already have it in our logs, but all of us are itching to get a shot at some of the more elusive ones, I'm sure. Is there anyone who wouldn't jump at the chance to work a ZA, YI, FO8 Clipperton, etc.? The questionaire will appear in a few months, and when you get your 73, don't forget to fill the thing out and send it in, so we can tabulate some meaningful country priorities.

The 1N2A that showed up on 20 Meters a short time ago has to be a phoney. The prefix is not assigned by ITU, and the Marco Island he purported to operate from is not listed in any of the four major atlases which I consulted. I cannot find any island in the area of coastal Peru which might be the one, for all those shown have well established names. Oddly enough, the signals peaked at approximately the right beam heading. My best guess is that someone was operating someplace in Ecuador, Peru or Chile.

I heard another lulu the other morning, claiming to be in Basra, Iraq. He was using G3NOF/YI and called himself Mike. The only catch is, G3NOF is Don McLean, a very good friend of mine in Yeovill, who's more interested in jazz recordings than in traveling for an oil company, which this joker claimed to be doing.

I simply can't understand the type of mentality which goes to the trouble of engineering a DX hoax. It's a lot of hard work; almost drudgery. And . . . for what? I think that most of these guys must suffer from vacant apartments in the upper storys.

Here's something that's bothered me for a long time. You hook up with a German, Czech or Russian. He speaks the English language with an accent, that's for sure. But, have you ever noticed, as I have, that his grammar is perfect in most instances. Syntax, number, gender and case are used properly. He never says who when he means whom. He doesn't mix up imply and infer. He doesn't split infinitives either. Yet, American amateurs, born and reared in this country, sometimes speak the most horrendously poor English to be heard anywhere. It is downright humiliating to hear some of the lingo that passes for English. As my friend W2NDK, Arthur Harris, says, "He don't speak so very many, but he doing the best what he are!"

I heard a couple of lads on 20 the other night who were having a time for themselves. They kept reducing power to see how long the copy would hold up. The fellow in Australia was audible here in New Jersey when he was reporting a dc input of 500 miliwatts. I lost the Ohio station at about 75 watts, but the VK continued to read him. It was most interesting. I understood why the VK came through so well when he described his antenna. He was using a wire quad; eleven elements on a 150 foot boom. I can't even visualize an antenna like that. Brother, that's what you call an aerial and a half!

During the course of the last year or so I have been QSL manager for Danny Willis, CT2AS. It is really surprising to see so many hams who are still unaware of the importance of getting the date correct, and making sure that the contact is logged in G.M.T. There simply isn't enough time in which to go hunting through hundreds of log entries in order to find one. It's the proverbial needle in the haystack. Please, everybody, get into the habit of using Zulu time.

We have finally gotten the new countries lists for WTW from the printer, and they are ready to be sent out to anyone who requests them. Remember, you will need one for each of the bands you intend to submit for, but they need not be sent in with your cards. You may transcribe the list on ordinary paper, typewritten, if possible, showing the contact and date. So long as this list is legible it will suffice.

Here are the currently claimed WTW scores. Some of you have been inquiring about countries lists. They are in preparation and should be available, soon. All who have requests in for them will receive them as soon as they come off the press.

It looks like we are close to our first WTW-300 certificate. I'd feel a lot better if there were some hot competition for this award. Many of you have evidently been lying "doggo" recently, for I have not been

getting too many revised claimed scores lately. How about pumping up those scores? Frankly, WTW is hurting from a drought of activity. There does not appear to be sufficient interest in the award at present, and the reasons for this may be many and varied. Not the least, I'm sure, is the removal of some of the frequencies formerly enjoyed by all of us. Rather than probe into those reasons, though, let's just say that we hope the inactivity is merely temporary, and that we can look forward to better conditions ahead. I'm pretty sure that if a rare one were to show up there would be a revival of interest. All we need is a Clipperton operation; Tokelaus, Chagos, Agalega, Kuria Muria, or the like, and watch those grounded grid amplifiers start heating up. The Malpelo action recently showed that there's still lots of life among the DX hounds.

The Coast Guard has now revised its former opposition to operations on Navassa. They will now permit ham operations there during the two times a year that a Coast Guard vessel in in the vicinity. This is excellent news, for there are many who have expressed a strong desire to go there. So I think that we can all look forward to another shot at this goodie in the near future.

WTW HONOR ROLL (claimed scores)

7 mhz-CW:

W4BYB	151
W3WJD	100
W8ZCK	100
VE3BLU	105 (new certificate)

14 mhz-CW:

WB6NWW	113
K4CEB	102
W8EVZ	102
W4CRW	101
WA2DIG	100
K8IKB	100
WB6SHL	100
W9HFB	100
W5ODJ	100
WB2TKO	100
WA9KQS	100
W1ETV	100
K5BXG	100
K4ASU	100
WA6GLD	100
W2UGM	100

14 mhz-Phone:

W6YMV	150
K2QOU	125
WB2NSG	122
K4GXO	120
K1SHN	111
W1SEB	110
W4TRG	106
WA4OPW	105
SVØWL	105
WØSFU	104
W3SEJ	103
CN8FC	103
VE3ELA	102
VE6AKV	102
K4VKW	102
W6OHU	101
W8WAH	101
WAØOAI	101

21 mhz-CW:

W4OPM	200
WØDAK	107
WA9NSR	103
WB2UDF	100
VE6TP	100
WA6GLD	100
WØRRS	100
WA9OTH	100

21 mhz-Phone:

W4OPM	220
WA5LOB	162
W6MEM	161
WA2FQG	155
WA1EUV	138
WA5DAJ	130
W9NNC	125
WB2RLK	110
W8WRP	106
W4SYL	106
W2PV	104
W1EED	103
K5HYB	101
W2VBJ	101
K4VKW	101
WB2OBO	101
K9PPX	100
W6YMV	100
WA4WTG	100
WAØOAI	100
WA8VFK	100

28 mhz-Phone:

WA5LOB	150
W6MEM	129
WA5DAJ	117
WB2RLK	115
W2PV	106
W2VBJ	104
WA7BPS	102
W4GJO	100
W5YPX	100

We are in need for check points in the 1st, 4th and the 10th districts. Also any clubs on the continent of Europe, South America and Africa wanting to take on this job, please get in touch with me through the magazine or direct, if you would like to help.

Here is a list of all current check points. We still need three more to fill out the roster

and I wish some clubs and groups would volunteer to complete our list. Meanwhile if your area is not covered, send cards directly here, at: 1 Daniel Lane, Kinnelon, NJ 07405, along with $1.00 to cover handling and cost of certificate, etc. If you wish your cards to be returned via registered mail, etc., be sure to enclose enough money to cover same, otherwise they will be returned at the cheapest rate; hardly the safest method.

1st District None (send cards here)

2nd District Peninsula Amateur Radio Club
Foot of 25th St., Veterans Park
Bayonne, NJ 07002

3rd District Western Pennsylvania DX Society
John F. Wojtkiewicz W3GJY
1400 Chaplin St.
Conway, PA 15027

4th District None (send cards here)

5th District Garland Amateur Radio Club
2905 Sheridan Drive
Garland, TX 75040

6th District Orange County DX Club
James N. Chavarria
3311 Stearns Drive
Orange, CA 92666

7th District Western Washington DX Club
William H. Bennett W7PHO
18549 Normandy Terrace S.W.
Seattle, WA 98166

8th District Straits Area Amateur Radio Club
William Moss WA8AXF
307 Grove Street
Petoskey, MI 49770

9th District Montgomery County Amateur Radio Club
Scott Millick K9PPX
Litchfield, IL 62056

10th District None (send cards here)

Canada (all) Edmonton DX Club
VE6GX, 12907 136th Ave.
Edmonton, Alberta, Canada

Oceania New Zealand Assn. of Radio Transmitters

Jock White ZL2GX
152 Lytton Road
Gisborne, New Zealand

South America Venezuela Amateur Radio Club
PO Box 2285, Attention YV5CHO
Caracas, Venezuela

As you can see, we are badly in need of additions to this list in Europe, Africa, South America and Asia. We could also do with one in Australia. Interested groups and clubs please contact me via 73 magazine or direct.

I take particular pleasure in announcing a welcome addition to our award. The Committee has agreed that we should establish two new categories. Here is the rundown.

MWTW, Mobile Worked the World, is awarded to mobile stations exclusively. The one band-one mode rule is bypassed for this category. All bands–all modes will count toward the certificate. The only stipulation is that any contact must be made with a mobile antenna. We will not honor any QSO known to have been made where a mobile rig was piped into a fixed station aerial, as is sometimes done on vacation trips.

WTWM, Worked the World Mobile, is awarded to fixed stations for contacts with mobiles, including maritime and aeronautical. In this category we will retain the one band-one mode rule. All other WTW rules will continue to apply, with respect to date of contact, etc.

After some thought, it has been decided that cards which may already have been submitted and counted toward an existing certificate, may be applied to the new MWTW award. If you decide to go for this certificate, you may re-submit any of them which might be eligible for inclusion. But, please make sure to note that they are re-submissions so that we have a record in your file.

We don't have the new certificates printed for these awards as yet, but you may submit the cards now. We will process them now and notify you at once, sending the certificates as soon as we get them. Please send your entries to me, direct, as the check points have not yet been notified of the new awards. Good luck to all participants.

We will not issue new certificates for credits above 200. Instead, we have designed an endorsement sticker, which is to be affixed to the original award. Any applicant for WTW-100 or WTW-200 will receive the certificate, and when he applies for 300 he will be awarded the endorsement.

This will save us a great deal of trouble and expense, and it will save you the cost of an additional display frame. Also, it will enable us to send you back your QSL cards plus the sticker in one mailing rather than

two. It will also do away with the problem of mailing tubes, which, I swear to you, is the biggest pain-in-the-posterior I have ever encountered. You cannot buy less than a gross of the bloody things, and when you do get them you have to find adequate space to put them. And, they collect more dust than you could imagine, but worse than that, they seem to be a natural habitat for honey-mooning field mice, wasps, spiders, carpenter ants and other unattractive varmits of varying descriptions.

There may be a few recently issued certificates whose holders are not listed this time. They will be included in the next publication of the list.

Next time we hope to have a report from Gus. Also may have some interesting disclosures from a well known former DXpeditioner who will tell all about some of his past corner cutting. This promises to open up a whole can of beans, and is guaranteed to turn a few faces red.

Next issue will include updated claimed scores, new certificates issued and order of standings. Don't forget about the new MWTW and WTWM. I'd like to see lots of applications in the mailbox. That's it for now. See you next month.

. . . K2AGZ

Try This One

Try this one on your friends and see how many will take the bait without giving it a second thought. The problem is: Your monitor scope has gone sour. The trace is very faint with the intensity control at maximum. You have checked the schematic and decided to measure the divider. According to the manual this point should be at -560 vdc in respect to the chassis. If you want to impose the least possible load on the circuit, do you use the 1000 volt range on your 20,000 ohm per volt VOM or on your VTVM, with its 11 meg input?

If you said the VTVM go directly to jail, do not pass go, do not collect $200. The correct answer is the VOM. The VOM on the 1000 volt range $\times$ $20{,}000\Omega = 20$ megohms, or nearly double the input resistance of the VTVM and for this reason would load the circuit only ½ as much.

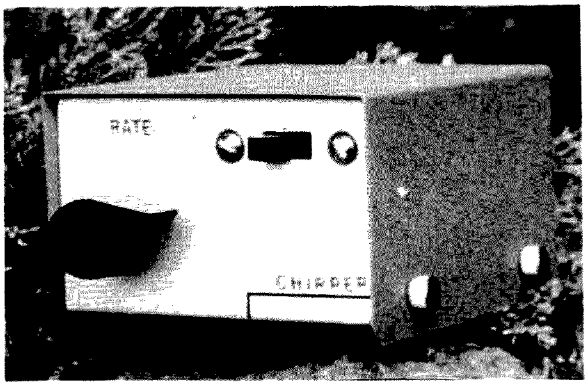
. . . . Bill Turner WAØABI

Chuck Hines K6QKL
8615 Idlewood Drive SW
Tacoma, WA 98498

FET Chirper

The Chirper is an automatically keyed, crystal controlled, signal source which may be used to optimize the signal-to-noise ratio of a receiving converter. Homebrew or commercial, converters are a common thing around an amateur station. And, most of the VHF Tribe have read thru a jungle of esoterica dealing with low noise front ends, the velvet beauty of FET's on Two, noise generators and eternal truth, and how to copy 20 db below the noise by the selective use of liquid helium. With a kind of relentless evolution converters have been getting better and better, noise figures become lower, and the prices of suitable front end devices are dropping by the hour. But when it comes to aligning these converters the scene is one of wretchedness. A black art at best, the job is taken up with an enduring combination of blunt instrument and myth. The latter have a certain charm. Are you convinced your converter is in top notch condition because you can "hear noise" when you attach the antenna – or better yet, when you place a 50 ohm resistor across the input? Try putting a complete short across that same input. Shorts aren't much good as noise sources. You'll find the short gives about the same change in noise level as the 50 ohm termination. What has changed is the impedance the front end "sees". The same is partially true of the noise from the antenna. Neither is indicative of the performance of the converter. Peaking the system up for maximum on either a weak signal or on noise gets you nowhere. The diode noise generator which every VHF book of substance describes is a good and useful tool when used properly. The assumption is that everyone already knows full well how to use it and does so. Few in fact do.

I'm sure you've read of it before in many places, but a little redundancy is in order. The noise with which you are concerned is the noise generated *internally* by the first tube, transistor, or other active device the signal encounters upon its arrival at your converter. By fiddling with the external reactances, adjusting the voltage and current and otherwise manipulating the things soldered to the device, one may minimize the internally generated noise. At the same time the reason the front end exists is to amplify the signal. One usually desires as much amplification possible, short of smoke and oscillation. Minimum noise and maximum amplification is the game. Though the two are not quite mutually exclusive a certain amount of compromise takes place. Thus, the signal to noise ratio. When aligning a converter's first stage every adjustment effects *both* signal and noise. Given a constant signal source coupled into the converter thru an appropriate impedance, the job is finished when the front end has been adjusted for the greatest *difference* between signal and noise of which it is capable.



The Chirper is designed to help you do all this by letting you see what effect each adjustment has on both signal and noise. The TIS34 oscillates at a frequency controlled by the crystal. With the constants shown, that can be anywhere between 8.2 and 36 MHz. The variable capacitor must be adjusted for resonance. It isn't particularily critical but its setting peaks the *rf* output at either the fundamental or some harmonic. For 6 meters an 8.35 MHz crystal is used. A 9.0 MHz rock will pin the meter when the Chirper is connected into a 2 meter converter. The Amidon[1] toroid is wound with No. 30 enameled, 40 turns for the primary and 5 turns for the secondary. After it is

1. 12033 Otsego St., N. Hollywood, CA 91607

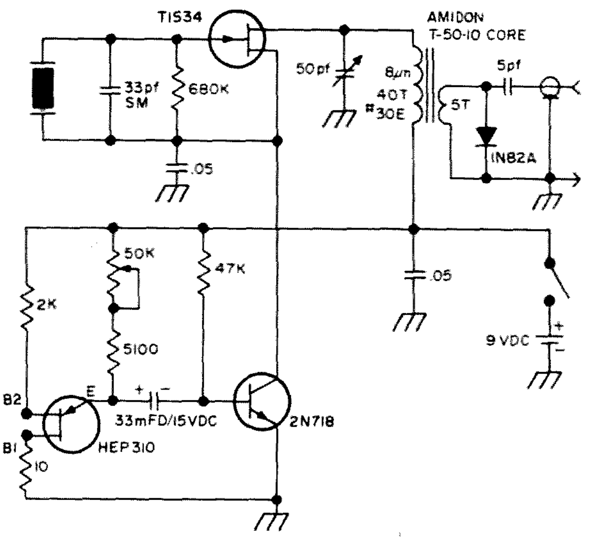


Fig. 1. Schematic of the FET chirper.

wound, spread the turns to fill the toroid and paint it with Q dope. The diode and 5 pF coupling capacitor are connected with the shortest possible leads, the diode being grounded at the *rf* connector. The harmonic output is excellent and quite useable at 1200 Mhz.

The oscillator is turned on and off by a multivibrator combination of unijunction and NPN transistor adapted from the *G. E. Transistor Manual.* The rate at which the multivibrator cycles is determined by the large value capacitor, in this case 33 mF. The polarity of the capacitor is critical. Observe it. To increase the cycling rate, decrease the capacitance; and, to decrease the rate, put in a larger value. Mine cycles a little under once per second. A value somewhere between 30 and 40 mF should suit your needs. You are better off scrounging some odd value from a defunct computer board because of the tolerance problem. If it says 33.2 mF, its probably pretty close to that value. Otherwise you're dealing with tolerances of plus 100% and minus 50% or something equally grotesque. The 50K pot determines the portion of the cycle during which the oscillator is On and is mislabeled rate on the Chirper shown. The HEP-310 is generally available and inexpensive. Other unijunctions were not tried. On the other hand almost any NPN of reasonable quality will work in place of the 2N718. A number of 2N388 and 2N3478's were tried and behaved well. It's a good place to use those transistors you've replaced with FET's. Use something with a Beta of 50 or better for best results. The 5100 ohm resistor in series with the pot is for current limiting. It's deletion will increase battery drain with no increase in Chirper performance. Normal current from the 9 volt battery is around 5 mA.

Construction is non-critical and pretty much a matter of taste. Mine is built on a piece of vector-board and mounted in a Suzurando[2] box, model M-1N. It measures 3¼ X 2 X 4" and there is still room inside for additions. It sells for 330 yen, about 92c. A slide switch is used to turn the power on and off. Paint one well of the slide switch with red paint – Testor's Pla, a model plastic paint, is good – and the switch will indicate its position. Red for On and black for Off. It saves batteries. Check your work and the polarity of the large capacitor. Re-check the connections to all the semi-conductors. With four different kinds of devices things can become confused. Set the pot to the middle of its range. Insert a crystal in the socket. Connect the Chirper to your converter, turn the switch on and adjust the variable capacitor for the highest reading on your S-meter. The oscillator will turn on and off. Varying the pot will extend or diminish the amount of time the oscillator is on. Whatever you do, *don't connect the chirper to an external antenna.* The harmonic content is high and even at this power level is sufficient to cause severe interference to television receivers within a two block radius.

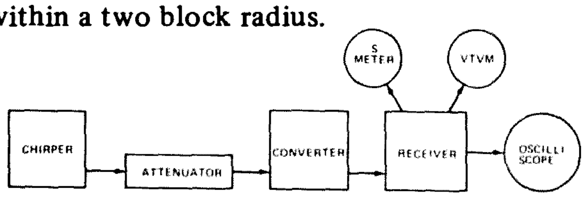
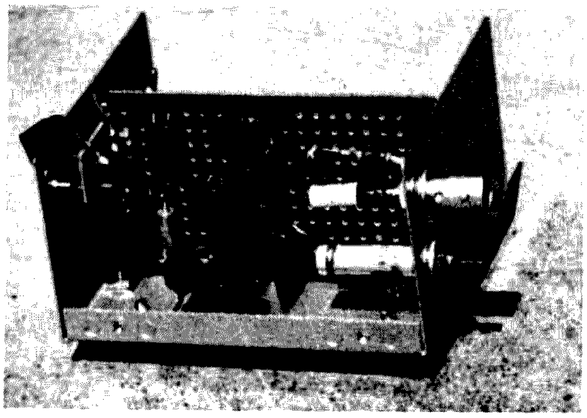


Fig. 2. Test set-up for converter alignment.

For converter alignment, the test set-up is illustrated in Fig. 2. The Chirper is fed to the converter thru an attenuator for two reasons. First, the power output of the Chirper is too high on six and two. You don't want to align with a forty over nine signal. Something around S-5 to S-7 is desired. Second, the attenuator maintains a 50 ohm termination for the converter. A converter cannot be aligned with a floating input impedance. Fixed and variable attenuators of excellent quality are available thru surplus and homebrew data is available. See *73,* January 67, p. 40 for one that will do the job. Turn the receiver avc off. The read-out options are diverse. The best is probably a scope connected to the *if.* A vtvm can be used, connected to the audio output. And, the S-meter can be used with the avc on *fast.* This will vary with the

2. Suzurando, 1-10-11 Sotokanda Chiyodaku, Tokyo



receiver and it's particular time constants. What needs to be avoided is avc pumping that interferes with your readings.

Turn the Chirper on, adjust the attenuator for a convenient signal level. When the oscillator is on, you're reading signal. When the oscillator is off, you're reading noise (on the scope, vtvm, S-meter, etc.). As you make adjustments on your converter, observe the effect on both signal and noise. Adjust for the greatest difference between the two. Turn the Chirper off and re-check the converter neutralization. If necessary, re-neutralize the converter and go thru the whole thing again. Talking about it makes it seem somewhat complex. It really isn't and the whole business won't take long once you've done it. It will become quickly apparent that highest signal level and lowest noise level do not coincide. You can vary the bias, voltage, etc., and observe the effects of each on the signal-to-noise relationship. You can, in short, optimize your converter's performance.

A number of things can be done with the Chirper. There is room in the box to build another oscillator section connected to the transistor collector, operating in parallel and simultaneous with the first oscillator. By appropriate choice of crystal and attenuation, both signals can be introduced into the converter in order to adjust the mixer for minimum cross modulation.

Or, instead of using an oscillator at all, you can use the switching section of the Chirper to key a noise generator on and off. This has a certain attraction where an integrating network is used prior to a vtvm. In this case noise is used as a signal.

In spite of it's name, the Chirper is remarkably stable. Chirp becomes apparent from two meters or so, but is no problem. Build one and take the myths out of your converter.

. . . K6QKL

The Inside Info on Alexander Graham

W. Edmund Hood W2FEZ
223 Pullman Ave.
Rochester NY 14615

As long as there have been radio amateurs, hams have been interested in the telephone system and sought ways to integrate it into ham communications. The worth of this idea needs no explaining. With their great tradition of public service and emergency work, ham operators have time and again proven their skill and efficiency in time of need. Nonetheless, in order to be a truly effective service, ham radio should be ready, whenever necessary, to utilize any and all media for communications. In spite of the fact that the two services grew up together, comparatively little data of any value is available for our use. Therefore the ham is often inclined to experiment on his own. This clandestine activity can have tragic results in the form of angry telephone officials, and, in some cases, can produce real damage to the telephone system, to say nothing of the expensive ham equipment.

In all fairness to the telephone people, it should be pointed out that a service so widespread as theirs can become nightmarishly complex. Take the telephone found in the average home. It's a lot more intricate than the cheap field phones they used to sell in the Radio Shack.

The diagram is the result of the dissection of a surplus telephone, rather than any revelation by Mr. Bell. With the receiver hung up, S4 and S5 are held open. A strong ac signal can pass through C2 and ring the bell, but the rest of the instrument is disconnected. When you pick up the phone, S4 and S5 close. As you start to dial, SI opens disconnecting the earphone, and S2 closes. As the dial returns, S3 opens and closes pulsing the line. You can follow the circuit from the red lead through S2, which remains closed until the dial reaches its rest position, then through the pulser, S3, through S5 (closed because the receiver is up) and out via the green lead. A dc voltage is present on the line, and the closing of S3 shorts it out, producing pulses which are sensed by the stepping relays at the central office.

After you have finished dialing, SI and S3 are closed, and S2 is open. The dc voltage now reaches the mike from the green lead, through S5 and S3, through the mike, then into the autotransformer, L, where it is stepped up and sent out over the line. The

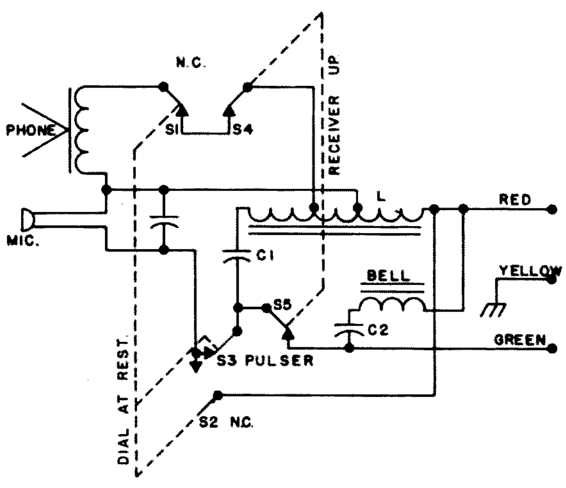


Fig. 1. Diagram of a run-of-the-mill Bell telephone.

capacitor, C1 blocks dc from the autotransformer.

The dc voltage on the line is in the order of 48 volts when it leaves the exchange, but can be considerably reduced by the time it reaches the subscriber. Sufficient tolerance is built into the system to allow a wide variation. The signal which rings the bell is a 20 hz. The voltage of the ac is 48 volts, but since it is superimposed on the dc, it can sum up to a total of 96 v. The dial tone varies from exchange to exchange. Anything that will make a sound will do.

A line from the exchange to the subscriber is called a loop. The overall impedance can range from 900 ohms to about 1.5 k., although they like to shoot for a happy medium of 1.2 k. Since the subscriber's telephone is midway around the loop, it looks into an impedance of around 600 ohms, and this value is the standard value used by radio stations in a remote broadcast loop. The frequency bandpass for conversational subscribers is 300 to 3khz. This has proven most effective for transmission of speech with the highest intelligibility. Broadcast loops come in several classes. One has a passband essentially the same as a standard telephone loop. This class is used most often for sports and newscasts. The class of loop used for disc jocky type programs, where some transmission of music is required, passes up to 8 khz., and finally, FM stations occasionally use the most expensive class with a full audio passband. (With very few exceptions, AM broadcast stations have an audio bandwidth limiting at 6 khz.)

Audio levels for the telephone system are centered around a reference (O db) of 1 milliwatt across a 600 ohm load. Broadcast loops generally hold their audio levels at 0 to +6 db. Home subscribers have no engineer to watch a level meter, and so it is difficult to pin down the audio level. Bell system engineers have no way of knowing whether the user will be a love-sick bobby-soxer or an eight-year-old telling grandpa about the fish he just caught. These represent two extremes for audio level. For design purposes, they try to consider the average of all voltage levels over a three-second period at -12 db. Using this figure as a design center, they are at least able to minimize crosstalk between lines.

When the receiver is lifted, and switches S4 and S5 close, a dc path is closed for the 48 volts on the line. The resultant current closes a relay in the central exchange which connects you into an available line to dial, and isolates your phone from incoming calls. As you dial, the pulser, S3, produces a series of brief shorts, so far as your telephone is concerned. At the exchange, however, these "shorts" are seen as a series of current pulses. These pulses go into a device similar to a stepping relay, which counts the pulses and connects your phone to a set of contacts determined by the first digit you dialed. Each set of contacts is connected to a second stepping relay. The relay on the set of contacts corresponding to your first digit is pulsed when you dial the second digit. This connects you to a third stepping relay, and so on until you have dialed the full number. The final position of the last relay is connected to the telephone you are calling. The presence of your signal trying to reach this number closes another relay which sets the ringing mechanism into motion.

The ringing mechanism sends a 48 volt ac pulse into the line you are calling. This pulse passes through the blocking capacitor and rings the bell. When that line is picked up, its current censor closes making the final connection. The ring pulse, by the way, is one of two possible signals, depending on the service you have. Both are based on a 5-second cycle. A "long" ring is on for one third of the time and off two thirds. Some phones ring in a sequence of two short rings, each one sixth of the time with one sixth interval between them, and then pause for one half of the time.

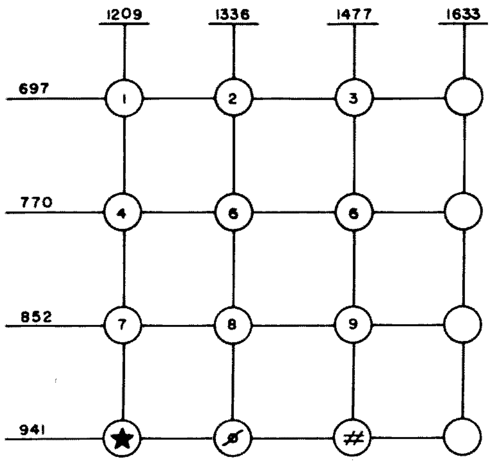


Fig. 2. Touch-tone switching matrix.

The touch-tone system, now available in some localities, sends a combination of two audio tones down the line which trip a frequency sensitive relay. From there the sequence is similar to the dial system except that frequency sensitive relays are used

instead of the stepping relays. The combinations are given in the matrix shown here. The tones for any given digit are determined by the intersection of the tone-lines at which the button is located. For example, the digit, 4, would send out a combination of 770 hz, and 1209 hz. The two figures in the bottom row, # and * are only available on certain military and industrial phones. The 941 hz signal only appears in a standard phone when the zero button is pressed. The fourth vertical row (1633 hz) is not used at present, except in certain data-transmission systems. For the most part, it is reserved for further expansion.

The descriptions given so far are a very simplified version of what goes on when you make a phone call. Multiply this by a theoretical ten million possible number combinations and you can get a slight idea of the nightmarish complexity of the system. One small goof by some character who doesn't quite know what he is doing, reflecting back through the central exchange, can upset the whole applecart. The telephone system, being an emergency service, is therefore protected by federal and state laws against any tampering that might disrupt the service or invade anybody's privacy. As one telephone engineer explained to me, "It's not that we're trying to monopolize the equipment, but unless we know what is hung on that line, we can't do our job. Also, you're paying for the service, not the lines. If you put on an extension phone of your own, you're taking service that you're not paying for."

Over the years, Amateur Radio has proven its worth time and again in emergencies. When disaster strikes, it is good that all services can work together and combine all available facilities for the public good. Now the telephone company cannot and does not object to the infinitesimal amount of competition offered by hams chatting long distance over the air. But when we use their own facilities to phone-patch a pleasure call in competition with them, you've got to admit that's getting a bit dirty. While the telephone company won't go broke from the loss of an occasional service charge, the reputation of Amateur Radio is far too valuable to allow it to be cheapened by so small a thing as that. What I have told about the telephone system so far, as well as what I am about to tell, is not by any means being revealed so that my brother hams can outsmart Mr. Bell, but rather, if the need should ever arise, that they might have the know-how necessary to make use of every available facility for the good of their fellow-men. In such a case as that, even the strictest of the telephone people would very probably go along with you. And so I clear my conscience with the reminder that you receive with this knowledge a responsibility to use it only to the greater credit of the fraternity. One clown can ruin things for all of us.

When it comes to coupling into a telephone line with equipment of other than Bell System design, we should look first at the broadcast stations. They do this sort of thing on a far larger scale than any other telephone company customer. In the broadcast industry the most common method is transformer coupling. Broadcast loops are generally treated as if they were 600 ohm balanced lines. Therefore, any 600 ohm transformer winding should offer a decent match. It is worth noting that the telephone people sometimes clear their lines with a high-power surge at around 500 volts dc. A blocking capacitor of sufficient capacity with a good high voltage rating can save you a lot of grief. Remember also that the 600 ohm winding only looks like 600 ohms if the other winding is properly matched. If the transformer has, for instance, a 10 K primary and a 600 ohm secondary, it must have a 10 K load across the primary. Also, some means should be provided to insure that the audio level does not exceed about 0 db, even if it means buying a meter. For those who want to stay on the good side of Mr. Bell, the telephone company makes available in many places a coupling transformer together with a telephone fitted to automatically remove it from the line when the receiver is down. After a $5 installation charge, it only adds 50c a month to your bill.

If you intend to record off the phone, remember that the law requires that a "beep" be sounded on the line, or that the other party know right from the start that a record is being made.

There are a number of low-priced induction pickups on the market which work by detecting the magnetic field of the autotransformer or of the earphone. These not only work, but they will also feed a signal into the line if the level is high enough. However, unless the other party is aware of it from the beginning, it may prove to be a violation of the federal wiretap laws. .

The diagram shows all the necessary

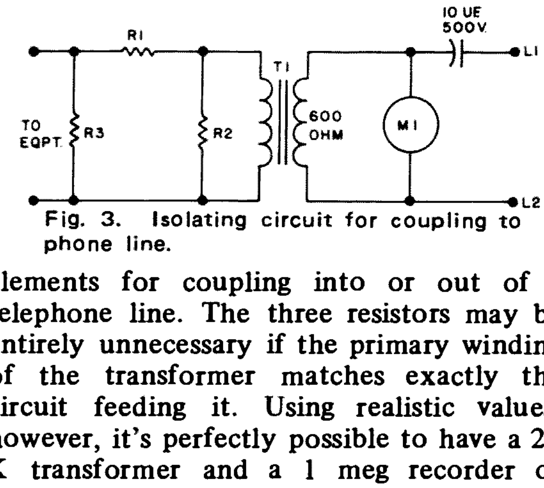


Fig. 3. Isolating circuit for coupling to phone line.

elements for coupling into or out of a telephone line. The three resistors may be entirely unnecessary if the primary winding of the transformer matches exactly the circuit feeding it. Using realistic values, however, it's perfectly possible to have a 20 K transformer and a 1 meg recorder or modulator input. If such were the case, R2 would have to equal the transformer impedance, (in this instance, 20K) R1 in series with R2 should equal the apparatus impedance (1 meg.) The values are different enough that R1 could be 1 meg, and the series combination of R1 and R2 would not make that much difference. With this arrangement, R3 could be left out. This could take audio off the line quite effectively, but it would have a 50:1 attenuation if you tried to feed voltage in. Much better to properly select your transformer in the first place. Taking another case, suppose you were using the same transformer as before, but feeding it from a 10 K source. R2 would still match the transformer, R3 would match the source (10 K), R1 would have to be about 10 times the larger of the other two (in the case, 200 K). If the apparatus had an impedance equal to the primary impedance of the transformer, you could then leave out all three resistors and there would be no attenuation. The meter, M1 is a standard VU or decibel meter to ensure that the lever going out onto the line were the same as that coming in (no more than 0 db). The capacitor serves to block against any high-power dc surge, and is picked so that the Xc is about 1/10 that of the line. I have given enough information for the ham who is reasonably proficient in the art to quickly calculate the proper values to meet his needs. In the interests of Amateur Radio, and also in the interests of the reader, if you cannot figure out the proper values with the information given here, I'd say don't mess with the line. Unless you really know your stuff, it's better for you to buy a pickup coil or pay the extra few bucks to the phone company for one of their couplers. . W2FEZ

Dave Mann, K2AGZ
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Kinnelon, New Jersey 07405

Leaky Lines

I've been lambasting the editorialist of QST for quite a while, on the basis of his ill-conceived piece last February concerning freedom of speech. After a couple of recent experiences, I have revised slightly my stated views on this matter, and would like to outline my current ideas on the subject.

You will recall that I opposed the notion that freedom of expression should be censored in any way. I said then that mature and intelligent people are capable of discussing anything under the sun without becoming emotional or insulting. I still feel this to be valid. Unfortunately, I did not take into account the fact that there are some who are not all that intelligent. I neglected to remember that there are people who will go out of their way, and seek deliberately to hurt, out of intolerance, bigotry, envy, or some fancied grievance.

There are many malcontents in this world, and we have our fair share of them in Amateur Radio. There are bullies, misfits, paranoids, and a whole range of peculiar types who are not prepared to maintain that degree of dispassionate detachment which would permit discussion minus any violent verbal abuse. The very existence of this group casts some skepticism into my mind now, about the wisdom of my words; I have misgivings.

It isn't proper, after all, to steer clear of foul language, if I'm going to turn right around and backbite some other ham. I may never utter a sacrilege, yet I may get away with slander, libel or I may bear false witness. Though I may avoid highly charged questions and political controversy, I may indulge in hypocrisy of the vilest kind.

There seems to be some idea that if a guy waves Old Glory and says he believes in the sanctity of motherhood and the home, he is then perfectly free to go on the air and express all kinds of poison, without fear of retribution. He can say anything, (so long as he doesn't cuss,) about another race, creed or color. He has only to avoid foul language, treason and sedition, heresy or irreverence, and he is within bounds.

I don't mean to suggest that we should not express dislike or disapproval. But, if you feel that someone is an unmitigated scoundrel or a plain louse, don't tell some third party about it on the air. It sounds horrible. Put it in a letter to him, or call him on the phone, and tell him. Or better yet, try to ignore the whole thing, and save yourself an ulcer. We'll all be better off.

* *

Apropos this question of contempt for others, I wonder if you've seen some "letters to the editor" from some of the younger hams. I'm getting a bit fed up with characters who automatically classify everyone over thirty an old fogey. They tend to put their age alongside their signature, as if to proclaim, "Look what a bright and precocious child I am. "

They say we aren't keeping up with electronics, and call us a flock of doddering morons. What a crock of sophomoric sassafras! There are all sorts of persuasions in ham radio. But I warrant that the very first thing that attracted almost all of them, like almost all of us, was the ability to communicate; that's the name of the game. Theory, design, research, construction and other technical facets almost invariably are a later development.

Why does a teen-age kid presume to tell his elders that they have no right to indulge their own particular desires and aspirations? Are only the young entitled to "do their own thing?" How do some people arrive at the startling conclusion that anyone who does not share their standards is somehow unworthy? Where is the justification for this canard?

This hobby is all things to all hams, and if some of these child prodigies don't like it, perhaps they should forsake ham radio and cultivate astro-physics, brain surgery or some other field wherein they may breathe the highly rarified air of genius.

I resent any implication that everybody who has achieved adulthood is a doddering, senile cretin who once passed a test, and has been stagnating and vegetating ever since. Perhaps we have lost some of our bounce, to be sure; that's life. But there is one thing we like to think; we try to get along. We try not to be rude and discourteous to others, most of us. And, with few exceptions, we do not treat our ham colleagues with contempt and disdain.

I'd love to be around to hear what some of these "young Turks" will say, some fifteen or twenty years hence, when some college punk, still wet behind the ears, calls them dead wood, and says they ought to "shape up or ship out."

* *

First "beisbol." Then motion pictures and TV. Then the motorcar and airplane. Then moveable type, penicillin, radio and the carburetor. Oh yes, pity poor Robert Fulton and John Fitch; The Russians also invented the steamboat; or didn't you know that? What will they claim next? This reminds me of the old Gershwin song which went something like, but not precisely like this:

They all laughed at Ivan Tomashevski
When he said the world was round,
They all laughed when Popovich recorded sound,
They all laughed at Vronski and Polonski
When they said that man could fly,
They told Kazullski wireless was the bull-ski
That's the same old cry.....etc.

I'd like to say a few kind words about SWL's. Not so much extravagant praise, but merely some recognition for the impulse behind the cards we sometimes get via the bureaus. I've noticed that in addition to the information they convey, sometimes surprisingly comprehansive with respect to conditions, propagation, and so forth, these people often display marked ability to copy code. Somehow it makes all the little carping complaints of the anti-CW proponents seem a bit unworthy. The hams who propose dispensing with the code as a requisite for a license should devote some thought to this. The SWL wants to accumulate QSL cards from hams. He therefore sets about learning how to copy CW. There is no requirement that he do this. The achievement is its own reward. He has a goal, and this provides him with the necessary incentive. How then, can hams indulge themselves and abandon themselves to inertia and indolence, bemoaning their misfortune at having to meet code standards, at the same time knowing that non-hams are beating them at their own game?

I hope the time will never come when CW is done away with. Not only is it an efficient mode of communication, but a time-hallowed and traditional part of our historical development. Many a golden chapter in the shining chronicle of Amateur Radio would never have been written but for this, our first and most venerable method of transmitting radio signals.

* *

Remember how Charlie Correll used to answer the phone? "Hello. Dis is de Fresh Air Taxicab Company. Andrew H. Brown, president, speakin'." Then came the sultry voice of the temptress, Madame Queen. "Hello, Andy." Andy's tone of voice would change completely. "Heeeee-lllోooo," he would drool.

I'm always reminded of this Amos 'n Andy bit, whenever I hear the following phenomenon.

A flock of guys are on the air, yapping about this and that; everything in general, and nothing in particular. Lots of kidding; references to graying hair or baldness, false teeth, and bulging waistlines. There's talk about grandchildren, mobile homes in Florida, and moaning over little aches and pains, bursitis and lumbago. In short, from all indications these gents are certainly well within the category of middle age, and perhaps just a teensy-weensy bit older.

All of a sudden a female voice is heard, 'way off in the distance, just about a smidgeon above the noise level. Immediately these elderly parties are galvanized into a strange and wonderful metamorphosis. In one fell swoop they not only develop super-acute hearing, but they seem to shed the accumulated years as a snake molts his skin. They revert to virile rooster-hood in an instant, and they become a gaggle of contending tomcats, serenading and caterwauling to some feline paramour from the backyard fence. They fall all over themselves in a spirited competition for the lady's attention. From the sound of the response to this tomatoe, you would think she was Raquel Welch, Brigitte Bardot and Sophia Loren, all rolled into one.

Next time you hear a YL breaker, pay particular attention to the atavism of all the old gaffers, and see if you don't get a great kick out of it. It's more fun than monkey gland extract, or a hormone injection, and who knows? It might just be the answer to the growing problem of geriatrics. There's nothing like a little old fashioned S - X to stimulate some life in the old bones, right?

* *

FAMILIAR SOUNDS DEPARTMENT

"Hello, CQ, CQ, CQ, from K2AGZ. Kilo two Alpha Golf Zulu calling CQ and standing by."

"K2AGZ. K2... ... Z. This is K ... ... Baker, wheeeeeeeeeeeeeeeeee.""QRZ, QRZ, QRZ. The station calling K2AGZ, please try again. QRM took you out. This is K2AGZ standing by for you."

"K2AG.......this is KR7 ... ... Whhheeeeeeeeee. Hello test. one two three four.....four three two one. Whhhhheeeeeeee squawk, splatter, squeak, crunch, bang, clang, crash, @†$%!&*() testing, testing, heeeeelllllllllloooooooooo test."

"KR7 question mark. KR7 question mark, this is Kilo two America Germany Zanzibar. I'm not quite getting your call, old man. There's heavy QRM, would you try it one more time please? Over."

"Heeeeeeelllllllllooooooooooo, test. BBBBbbbbbZZZzzz. RRRRrrrrRRRRRrrrrr. Burp, wah-wah-wah, tweet tweet tweet tweet. Whistle, tweedle-dee-dee. Hallllooooo, test. is anybody using this frequency?"

"Nobody is using it. Go ahead, old man. You're a real nice fellow. K2AGZ clear and QRT." * * *

* *

In keeping with my generally iconoclastic attitudes, I'd like to give the "back o' me hand" to all these self-appointed watchdogs who seem to have proliferated recently on the bands. These screwballs, of course, did not just appear out of nowhere. They were spawned, in my view, by a recent editorial in a certain magazine which saw fit to open a whole can of beans about self-policing ourselves.

Now, there's nothing new about this. Indeed, we have been discussing it for years. In fact, it is the number one subject of the speech made by the Director of any given section, at the annual roast beef dinner of the Radio Club. But this time it was a bit different. For the very first time, someone came out in print, favoring the vitiation of one of our basic Constitutional privileges, Freedom of Speech. But Freedom of Speech is like pregnancy or death. There's no such thing as a little bit of it. You either have it or you haven't!

A typewriter is like a gun. It will shoot anything you point it at. The man behind it must exercise good judgment at all times. In this

particular case the man behind the typewriter, obsessed with his own brilliance and wit, having to come up with a column about something or other, allowed himself to make an error of judgment . He exhumed this moldy fig from his mildewing trunk of ideas, never reckoning that it might raise a stench. And he underestimated the common sense of the readership!

For years and years hardly anyone ever took issue with the pronunciamentos which came down from New Mount Sinai, Connecticut 06111. Sacred cows, like other ruminants, become so absorbed in the chewing of their cuds that they develop total obliviousness to their surroundings; a sort of self-mesmerism. But in today's world things are different. There are no longer any sacred cows. Or, if there are, they simply are not venerated any more. Poor old Hirohito celebrated his birthday the other day, and it rated three lines on page 27 of the Paterson Evening News. 'When Mr. H. H. Humphrey crossed the street in St. Paul, a cab driver honked his horn and snarled at him, and two elderly Republican ladies made a rude gesture. Sic transit gloria mundi!

The Editor never considered that this piece would provoke a deluge of protest. Who woulda thunk it? Wonder of wonders? from the Sanctum Sanctorum an encyclical had been pronounced, yet it was not accepted unquestioningly as dogma. This was decidedly not the reaction he had anticipated.

So......in the next issue but one, along with some of the letters of objection, the Editor wrote some minor retractions and statements of clarification, which sounded, for all the world, like backtracking. He had to, for clearly, the natives were restless. To the everlasting credit of amateur radio, people who rarely expressed any opinions at all, wrote articulate, intelligent, and even brilliant denunciations of this attempt to stifle free speech on the bands.

Of course, there were some who agreed with the editorial. I have heard a few of them, anonymously playing "vigilante" on the air, taking issue with those with whom they disagree. Mostly they concern themselves with an occasional hell or damn. One of these persons is a confirmed addict to the use of "By Golly" and "Jiminy Cricket".

Consulting my Partridge's Dictionary of Slang, I came up with the following. By Gosh, By Golly and By Gum are expletive substitutes for the Name of the Deity. Strange to say, the mild expressions, Goodness Gracious and Doggone It are similarly derived. Since one of the Ten Commandments expressly forbids taking the Name of the Lord in vain, somebody devised this method of cussing without actually being profane. Semantically speaking, however, the changed words do not change the substance or context; it's still swearing.

Jiminy Cricket, Jumpin' Catfish, Gee Whiz, Criminy and Cripes, are all derived from the Name of the Saviour, and their use is every bit as objectionable as would be the use of His Name, as innocently as they sound!

Shucks, Pshaw, Shoot and others beginning with the consonantal diphthong "sh" are all meant to take the place of that nasty pejorative which refers to a certain biological function, the less said about which, the better. In this group is included the non sequitur, horsefeathers.

Fudge and Phooey I leave to your imagination; this is a family type publication!

I hesitate to speculate upon the derivation of things like I'll be hornswoggled, or I'll be jiggered. But drat it, darn it, what the heck, and son of a gun are perfectly obvious to anyone with half an ear for sounds. I did not investigate either, into nifty, to get one's wind up, or the often used bodacious.

If you are interested in just how hairy this question of linguistics can get, just try using the terms, slowpoke or bugger, while talking to a Britisher. You're likely to get your head handed to you.

Well, what I've been driving at is this. I would far rather hear someone say an occasional hell or damn than some of those overdone cliches which are accepted as innocent. There is no valid reason for a Cripes man to look down his nose at a Hell's Fire man. If the latter were to say Brimstone and Ashes, or Perdition, it would not even get a raised eyebrow in polite society. Yet, the meaning is exactly the same.

Let's face it; language belongs to those who use it, not to those who would like to regulate and limit it. And if you really want to get down to cases, it's not really the words these people are gunning for. They are trying to shoot down the ideas that are expressed by words. And ultimately to take away your right and mine to express them.

* * *

Would someone please explain......

Why the hardest thing in the world to get is an honest audio report.

Why the next hardest thing to get is a rotator that doesn't quit during the worst blizzard of the winter.

Where to find a ham who is satisfied with your S-Meter.

Why the guy with the most atrocious banana-boat swing is the most zealous opponent of electronic keyers, on the grounds that they rob fists of individuality.

Why your XYL insists upon using the vacuum when the signals are marginal.

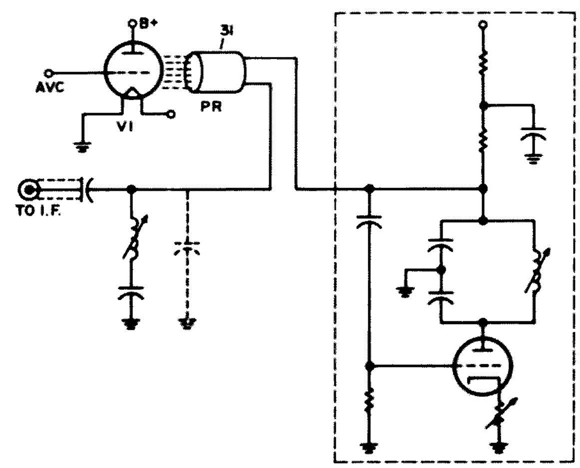
Why certain hams send CQ at a swifter rate than their ability to copy, and when you match their sending speed exactly, they request you to QRS.

Why some ignoramus breaks, uninvited, into your discussion without identifying, and demands, "Why don't youse guys stop talkin' about all that political crap? Dontcha know that controversial stuff is outa bounds? What are ya anyway, a bunch o' commies?"

Why the lid who starts calling CQ on your frequency always says to the guy he hooks up with, "We're getting QRM'd. Boy, I dunno what's happening nowadays on the ham bands. There's just no courtesy anymore." But don't get me wrong.........I love Amateur Radio! . . . K2AGZ

Autobandwidth

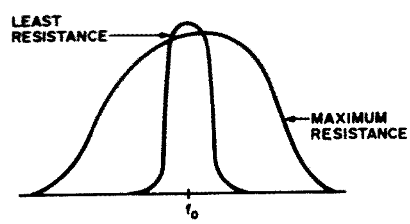
The accompanying diagram is an automatic bandwidth control circuit for the *if* strip ot ham receivers. It will give a minimum bandwidth of 1800 hz, with a signal input at the antenna of 1 uv and the maximum *if* response for signals greater than 1000 uv. Since the choice of photo cell PR governs the actual extremes I shall not quote any figures.



VI emits light and is controlled by the AVC.

Photo cell PR is in series with the Q multiplier set in its minimum bandwidth condition and therefore continually adjusts to the signal tuned. It is quite effective for weak signals, giving a better signal/noise ratio. It is operated by a simple switch.

The patent for this device was granted January 4, 1966, number 3,227,961.



In the actual unit many cells seeing different parts of the visible spectrum were tested.

Since the idea is simple, I will say no more.

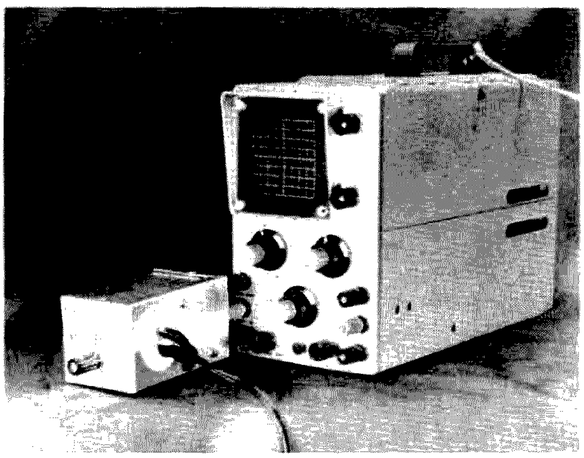
Roderick A. Johnson, K1PIZ

George Wilson W1OLP
318 Fisher Street
Walpole, MA 02081

Scope Calibrator

Introduction

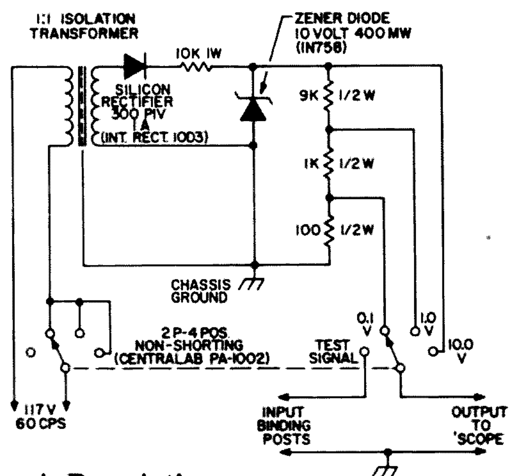
Instrumentation for the amateur who does his own design, construction and repair work has improved remarkably over the past twenty years! It is hard to imagine how we tuned antenna systems without VSWR meters and forward/reverse power meters. Most of us were lucky if we had a simple volt-ohm-milliameter. Those of us who knew what an oscilloscope was considered it far-out for application to our amateur problems. Today we have a wide range of instruments available, varying in sophistication from the spectrum analyzer ("Panadaptors" and similar instruments) to gadgets like the calibrator to be described in this article.



Functional Description

Perhaps the most frustrating aspect of using an inexpensive oscilloscope is its lack of voltage calibration. This frustration can be easily eliminated by the addition of an external calibrator which allows the signal under test and the calibrating signal to be switched without disconnecting and reconnecting the oscilloscope leads. The calibrator produces square waves of known voltage amplitudes. With one of these square waves applied to the oscilloscope's input terminals, the gain of the oscilloscope is adjusted until the signal height on the tube face is a convenient number of divisions when measured by the reticle in front of the tube face. Typically, a ten-volt square wave may by applied and the gain adjusted such that the square wave is ten divisions high on the reticle. Each division on the reticle is then equivalent to 1 volt. Similarly, if a one volt square wave were applied and the gain set for ten divisions, each division would represent 0.1 volts.

OSCILLOSCOPE CALIBRATOR



Circuit Description

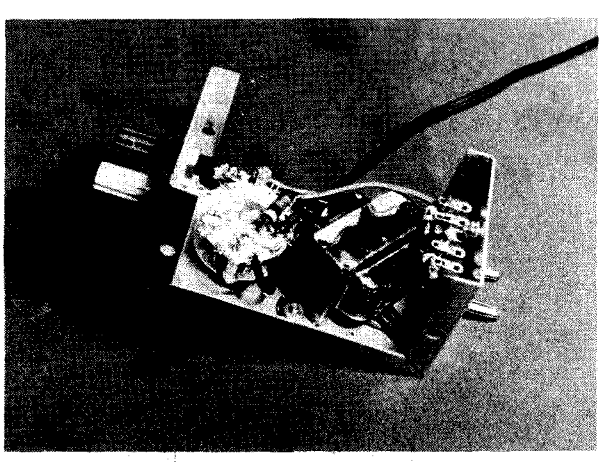
The calibrator circuit (see circuit diagram) consists of an isolation transformer, a rectifier, a Zener diode clipping circuit, a step attenuator, and a selector switch. The isolation transformer minimizes the electric shock hazard. Note that an electrostatic shield between the primary and secondary is suggested to minimize the coupling of 60 hertz hum into the oscilloscope's input circuit. The rectifier reduces the sinusoidal voltage across the transformer's secondary to a "half sinewave," i. e., to a half-wave-rectified waveform. The clipping circuit further reduces the waveform to a form very close to a squarewave with peak-to-peak amplitude of 10 volts. The step attenuator provides outputs of 1.0 and 0.1 volts; these, and the basic 10 volt square wave, may be selected by the switch.

Physical Description

The calibrator is built in a 2-1/4 x 2-1/4 x 4 inch minibox. The layout of parts is simple and not critical and, therefore, no drawings have been included in this article. Care should be taken to shield and separate the test signal leads from the 60 hertz calibration signal circuits.

A pair of banana plugs are mounted on 3/4 inch centers at one end of the minibox. These plug directly into the oscilloscope's input terminals. A pair of terminals similar to the oscilloscope's input terminals are mounted on the other end of the minibox and are used to connect the test signal.

The switch has four positions: test signal, ten volts, one volt and 0.1 volts. This choice of calibration voltages will allow full-scale calibration of the oscilloscope in the range from 0.1 volts to 100 volts.



Conclusion

The convenience afforded by this calibrator makes it well worth its cost and the time necessary to build it. Its accuracy is governed by the accuracy of the Zener diode. The diode specified in the parts list will give 5% accuracy which is similar to the accuracy provided by common panel meters. Additional accuracy is probably limited by the oscilloscope's deflection linearity and the width of the oscilloscope's trace.

This device will greatly simplify work on both transistor and tube circuits. It makes an oscilloscope double as a vacuum tube voltmeter at minimum cost with the convenience of not having to connect a separate instrument to make voltage measurements.

. . . W1OLP

Vidiots That Have Known Me

Robert Manning K1YSD
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"Hey, you, you jerk! Yeah you, the ham-operator dum dum!" A voice boomed out into the morning stillness and assaulted my eardrums as I was leaving for the unemployment office (I'm having trouble getting work in my chosen profession. There's not much call for a human cannonball anymore—especially since the last time out I overshot the net, carromed off the cotton candy machine, which ran amuck turning most of the audience into a cluster of Bo Jangles looking for a Shirley Temple, landed smack on top of the tatooed lady, turning her black and blue and obliterating most of her artwork, startled the fire-eater who hiccoughed and set fire to the bearded lady which scared hell out of the sword swallower, causing him to inadvertantly release the spring catch on a Malayan machette thus performing not only an auto-appendectomy, but much more serious damage. To this day, whenever he sees me, he kicks off his high heels, lifts his skirt and tears after me shouting all sorts of threats in a shrill voice! I don't know what his complaint is—they named a sandwich after him—sliced chicken).

The roar had emanated from one of my female neighbors—you know the type—so misshapen and ugly that if she'd been seen by Moses, there'd have been eleven commandments. She is the possessor of a cavernous mouth so large that, by comparison, a 7 ply 6:00x16 Goodyear white wall looks like a licorice-and-peppermint lifesaver. "Do you know," she thundered, "that every time you play with that radio junk of yours, my toast turns black and I start hearing things?"

Remembering item No. 32 from the pamphlet, "How To Handle TVI Complaints With Tact and Diplomacy," I deported myself like any other mature, gentlemanly, self-respecting ham would have done under similar circumstances. I jingled the change in my pocket, brushed back my Alan Ladd forelock, straightened my tie, wound my wrist watch, picked my nose, checked my zipper and, with a yell of "Blow it out your smokestack you beady-eyed daughter of an illegitimate pickpocket!", I hurled the largest rock I could find at the big-mouthed old bat!

Unfortunately, I missed the old bag—my knuckleball just isn't what it used to be—and

hit her pet, "Heinrick," New England's largest living carnivore—a German shepherd—an animal with the mentality of a citizen bander, the disposition of a newly appointed "OO" and singularly devoid of any form of mirth who'd obviously read *Mein Kampf* and bore a grudge for losing WW II.

Taking refuge in my car, I watched the beast eat my fender, headlight, rear-view mirror and top it off with my two-meter halo.

Finally, fully gorged, fully sated and having vented his spleen, he started back towards his owner. I couldn't resist one parting reparté as I drove off in my now fender-light-antennaless car, and I said, speaking to the dog but in a voice loud enough for the neighbor to hear, "See ya, Heinrick, and tell your 'mother' (with all which that implied) that if she keeps hearing things, the men in the Good Humor uniforms with the snow-white, crepe-soled sneakers are going to certify her as a class "A" goober and wheel her off in a wire mesh basket wrapped in a wet bed sheet!"

As I rounded the corner on two wheels—chortling and wondering where I was going to get a fender for a '36 Hudson Terraplane, I heard a loud crash from the rear of the car. Later investigation showed that I had solved one of the old broad's problems. If she wanted any more toast—black or otherwise—she'd have to run an extension cord all the way to my license plate and trailer hitch.

This is but one of the 800 I.T.V.I. cases that I had been involved in during a five-year tour at a trailer park (ofttimes referred to as a "horizontal high rise" or "an instant slum"). [Now, if the type-setter has kept out of the Haig&Haig, isn't hung over and hasn't been distracted by a passing micro-mini skirt, as I suspect must have happened in three of my last four articles, since, in each case, a key word was changed, turning an otherwise humorous paragraph into a meaningless jumble of unconnectable words, you will notice that I said I.T.V.I.]

ITVI is a little complicated to define. The initials, of course, stand for Imaginary Tele-Vision Interference, but it goes much deeper and is more profound than simple imagination on the part of an arbitrary or isolated television viewer.

ITVI is the product of the bigotted and stagnated mind of *"The VIDIOT."* The Vidiot (Video Idiot) has become an ever growing ethnic group within our society—moving into "1984" and "Big Brother" twenty years premature. He is totally mesmerized by that flickering rectangular eye. His entire thought processes, eating habits and even his sex life are controlled by CYCLOPS! . . . CYCLOPS all hail the one-eyed God! . . . "Johnny has to be in bed by half past the Flying Nun" . . . "I want you home before The FBI" . . . "The roast will be done about quarter to ADAM-12 . . .

(One Vidiot I know of became so despondent when his set was removed for repairs that his wife was forced to light up the aquarium, sit him down in front of it and keep reassuring him that it was a Jacques Cousteau Special. When that wore off, she mixed him a "Missing TV set cocktail"—six parts prune juice to one part gin—the Vidiot knew the TV was missing, but he was too damned busy to really care.)

The Vidiot comes in two forms. The type that has jumped from infancy to senility completely omitting maturity, and the type that exists in a limbo state of arrested pubescence!

If you felt the urge for creative analogies, you could call them Vidicon Buddhists—differing from the "navel contemplating" Buddhists only so far as the location of the navel to be contemplated is concerned. The Vidiot searches for Nirvana through a transplanted electronic and transistorized navel installed in a cabinet, but is nonetheless connected to it by an ivisible optical/auditory umbilical cord.

Imaginary interference can be conjured up in the mind of a vidiot at the slightest provocation (especially during one of his favorite programs—like BOZO or Dark Shadows or the Late Night Movie showing, "The Oyster that swallowed Mt. McKinley"), and at the first flicker he can be expected to leap into the air with a rousing, "HUZZAH!", whip his bumbershoot out of the elephant foot, slam his purple pith helmet on his head, yank open the door, and, like some modern Don Quixote, wearing only the CD pith helmet, jockey

shorts and mucklucks and waving the bumbershoot in one hand and a TV Guide in the other, race into the night screaming, "I know you're out here—my TV is flickering!"

Where do vidiots come from and why do they hang to this outmoded belief? This fallacy—like burying a hank of hair and a fingernail at the full of the moon to rid yourself of warts, eating raw eggs to improve virility, or buying *Playboy* "just for the articles" has been passed on from vidiot to vidiot—stupidity is not contagious, but to *not* believe would mean that Cyclops is not infallible.

TV repairmen live in constant terror of a call from a vidiot where the set will have to be removed. The "sophisticated" repairman comes armed with COPE, NERVINE and MILLTOWNS; the "average" repairman simply brings along a leather strap or a bullet for the vidiot to bite on while the repairman pries his fingers off the fine tuning knob; but the uncouth repairman simply walks in and bludgeons the vidiot with the stubby end of an Indian club.

An ITVI or Vidiot call can almost always be distinguished within the first few words of the conversation. The vidiot has a tendency to "gild the lily," the voices he hears *always* "sound" like a ham, the lines he sees *always* "look" like the lines of a ham, and more often than not he'll claim that he's hearing Morse code.

You know this "frogmouth" wouldn't know Morse code if Marconi, Samuel B. Morse and Hiram Percy Maxim were all simultaneously hammering out "CQ DX" on the frontal lobe of his cerebrum with an axe handle, a No. 9 iron, and a croquet mallet respectively.

It was a common, rather than uncommon, thing to be interrupted during snoozes, showers and other nefarious activities by the ringing of Alexander Graham Bell's dubious contribution to moderna. (Incidently, I have definitely established that the first phone conversation was not "Mr. Watson, come here I want you!" but rather a call from the downstairs neighbor complaining that Mr. Bell's infernal machine was interfering with the operation of the neighbors' VICTROLA, making Enrico Caruso sound like a baritone!)

When the phone rings for a TVI call, as some of you are undoubtedly aware, it seems to possess a special tonal quality—sort of a cross between a death knell and the noise your car makes 30 minutes after you've mailed off the last payment.

Picking up the phone on these occasions I'd say in my most cordial manner, "Hello there! Whom have I the pleasure of addressing over this veritable miracle of electrical science?" After a slight pause, a voice would rumble back, "Listen you wacky nut—you're on my TV and if you don't stop it, I'm coming up there and whomp you on the top of the head with a 2x4 until you're bowlegged from the neck down!"

"Ah, forsooth," said I, remembering—be nice, be calm. "If you will tell me where you reside and abide, I'll come down and take a look at your TV, for, verily, I haven't had my rig on in almost a fortnight!"

"Whazzat? Whazzat? What the hell are you talking about? Huh? Huh?"

"I said, where do you live, stupid?"

Living as I did in a trailer court where your furthest neighbor was as close as 100 yards and where there were over 80 TV's within the area, I thought it a good practice to visit anyone with a complaint—just to keep good will up and rumors down. In all 800 cases, I never had a bona fide case of TVI attributable to me. This gave me a first-hand look at a continuing flow of vidiots which defies description. At one time I thought that I must possess some inner personal magnetism that attracted the lunatic fringe like ZSA ZSA attracts and accumulates jewelry.

With each call, I would dutifully don my "technical-type" coat—actually a sanitation engineer's coat which I'd appropriated at a Trailways bus depot—and picked up my Interference Portmanteau, which contained on one side TVI brochures, high pass filters, wave traps and some test equipment (all about as useful in ITVI cases as the "pill" is to an octogenarian). On the other side, I carried my Vidiot Analytical Conglometer.

In order to understand the V.A.C., you must first understand the mental workings of the Vidiot. He will not install a high-pass filter or a wave trap, even though they're free. He wants someone or something he can

blame, hate and rant about. The V.A.C. is my own design and is flexible enough to handle most vidiots.

The Vidiot Analytical Conglometer is housed in a 5x6 mini box. There are only three basic parts to it: (1) A small variac coupled to an ac meter and ac plug. The meter is labeled in five stages. Depending upon the vidiot you are dealing with, you can adjust your conglometer to read the cause of his problems as being A, the weather; B, the bomb; C, the Russians; D, rockets; and E, UFO's. (2) The second part is a 3" speaker with alligator clips to parallel to the output of the TV–if you can cause a feed back squeal, you can make him believe anything. (3) Appearance–the conglometer has got to look impressive. I have a rotatable tea strainer plumb on top and a two-section auto antenna on the side, plus a number of lights, knobs and other assorted junk.

I cannot possibly recount all 800 ITVI cases, but I can give you a typical incident.

Clad in my technician-type coat, I journeyed to the home of the complainer. My eyes had become accustomed to the dark by the time I arrived. (Vidiots always call at night.) So as I entered the dark, murky interior, I could easily make out the semi-prostrate form of the vidiot with his hair hanging down into his can of Black Label which he clutched as if it would take a skin graft to remove it.

I was immediately accosted by two animal forms. The first, a future vidiot–a sticky jam, tar- and glue-fingered, curtain-climbing, crumb-grabbing, rug rat that attached itself to my leg like Sinbad's "old man of the sea," shrieking and screaming something totally unintelligible (all vidiots have one or two of these around the house; and the second was the smallest, nastiest, noisiest, most pop-eyed Chihuahua that I'd ever seen.

"Clem," came a voice from the kitchen, "tell the man he won't bite!"

"The dog or kid, lady?" I asked. "I don't mind that bug-eyed canine chomping on my shin bone, but if that kid so much as breaks the skin, I want a tetanus shot right away!"

About this time, Clem, the vidiot, demeaned himself to notice me, and brushing the ashes and crumbs from his gravy and beer stained "T" shirt, he looked up but didn't get up, and in the vernacular of all vidiots, he said, "Dahh, so you're the ham bum that's been screwing up my TV, huh?"

"You tell him, Clem!" came the voice from the kitchen.

"Look neighbor," I said, trying desperately to drop the portmanteau on top of the dog while trying to get a death grip on the 40 pounds of animated garbage who was now not only trying to get his gooey hand into my pocket, but also doing his level best to break every bone in my instep. "I came down to see if I could give you a helping hand. I haven't had my rig on in several days–now where's the TV set?"

"Don't gimme that crud!" he said.

"Tell him off, Clem," came from the kitchen.

"I know all about you hams . . . yeah, we had one of you guys back in Oklabraska–soon as the old man left, the old lady'd get on there and start making dates all over town. Then the kids would get on there and talk to each other," he grumbled officiously.

"Tell him, Clem!" came the voice from the kitchen.

"And another thing," he said, turning to get another beer (I seized this opportunity to Norden Bombsight the goddamn dog and surreptitiously twist the kid's ear a full 180 degrees–both went screaming–louder, if that's possible–into the kitchen), "That big antenna of yours is sucking all the power out of my set."

"Tell him off, Clem!" came the voice from the kitchen (unbelievably over the wailing din of a scrunched dog and a twisted-eared kid).

"You suppose you could show me the TV set and keep the commentary for later," I said.

"Smart Bustard, huh? That's it over in the corner. Maw had it for 15 years and we've had it for 5. Never had any trouble except for you hams," he said, indicating a large, brown crate about the size of a restaurant freezer with what appeared to be a broken coat hanger with tinsel hanging off it.

"Where's the screen?"

"Right there, that six inch hole, see the flickering? You're doing that. See what you're doing? Huh? Huh?

"Tell him off, Clem," came from the kitchen.

"I'm standing right here, so what can I be doing? You ever think about having 'er stuffed?"

"The TV?"

"No, that voice from the kitchen!" Ducking a beer can, I continued, "Buddy, this set is 20 years old and the only way you're gonna get a picture on it is with the help of Timothy Leary!"

"Who's he? Another screwy ham?"

"Tell him, Clem," came from the kitchen.

"Ya know, friend," I said, "I could solve all your problems just by inserting a small piece of lead in your left ear!"

"That would fix everything up, huh?"

"As far as I'm concerned, it would!"

"How would you insert the lead?"

"With a .38 Smith and Wesson . . .

. . . K1YSD

(Type-setter's note: I am not distracted by micro-mini skirts. However, the editor's Bermuda shorts occasionally catch my eye . . .)

Mobile Transmitter Heater Switching

In amateur FM communications operation long periods are spent monitoring a sometimes vacent channel with relatively few transmissions. When I converted an old rig to put in my car, it soon became apparent that keeping the transmitter filaments hot would result in a considerable power waste from the already overtaxed car battery. The receiver uses many filament type low current tubes, but the transmitter heaters waste power. The rig is remotely controlled in the trunk by a control head and connecting cable. No means was provided to allow separate switching for the transmitter heaters.

To solve this problem I devised a switching method that allowed the desired control, but with no extra switches or cables on the control head. The scheme is shown in Fig. 1. When the receiver is turned on, the transmitter filaments will not be turned on until the microphone push-to-talk button is pushed. When the button is pushed, the T–R relay and K1 will be activated. As K1 pulls in, it in turn turns on K2. One set of contacts on K2 activates the transmitter heaters, and the other set of contacts holds K2 in continuously. When you wish to turn the transmitter heaters off, simply momentarily turn the receiver power off and the voltage to K2 will be gone. The receiver can then be turned on without activating K2, unless the push to talk switch is activated.

In my case, K1 was not necessary because the T-R switch had an extra pair of contacts. Be sure that the contacts of K2 can handle the current that your transmitter requires. Six volt relays can be used with series resistors calculated from Ohm's Law, although this will add to current drain.

This system can increase power waste during transmission because of the relay current, and some people may not like to wait for the transmitter to warm up. However, this was a good solution in my case because of my style of operating and limited activity on our local channel. If you don't like to waste power, and you don't like to run cables and install switches where there is no room for switches, this system may solve your problems too.

Clifford Klinert, WB6BIH

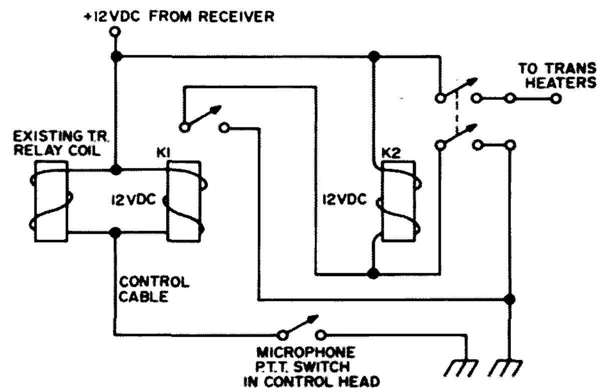

Fig. 1. Power saving heater control.

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The Protector

Here is a practical circuit to have around. It can be used for protecting your ham gear or perhaps your expensive new color TV. A fellow at work was telling me how his house power went on and off three times in rapid sucession during a storm. He and his family were watching their color TV at the time. After the power settled down, his TV didn't work and it cost something like $130 to get it all straightened out. This got me to thinking about what such an occurence could do to my new solid state color TV.

The Protector is what I came up with. Here's how it works:

When 115 volts ac is available at the plug, and the fuse is good, the Reset Ready light will come on through pins 2 and the normally closed pins 5 and 8. Then you press the momentary Reset pushbutton. This operates the relay by putting 115 volts across pins 7 and 2, which is the relay coil. When the relay operates, the Reset Ready light goes out due to pins 5 and 8 opening. Pin 8 closes to pin 6, which is wired to pin 7 and the relay "locks up" through its own contacts and stays operated even when the momentary pushbutton is released. The 115 volts for the output receptacle is taken from pins 6 and 2 which are in parallel with the coil. The "Thyrector" across the output is to limit any surges or transients in the house current.

If the power should go off or dip to about 85-90 volts on my particular one, the relay will drop out, opening pins 6 and 8. Now even if the power comes right back on, there is no path to energize the coil or supply power to the output receptacle. The circuit will stay this way until the reset button is pushed.

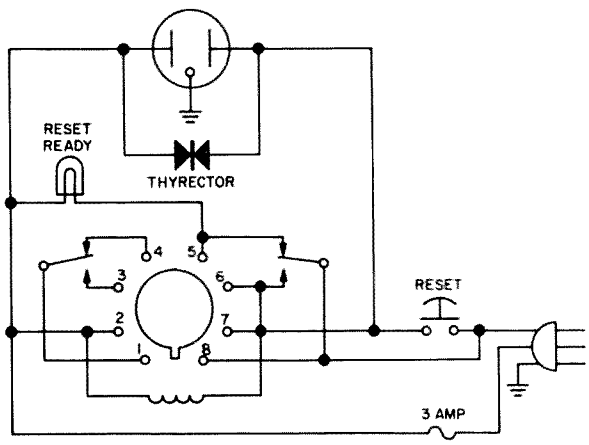

Fig. 1. Diagram of the protector using a G.E. thyrector, No. 6RS20SP606.

I used a Potter & Brumfield KRP11AG because I had one around. Just about any single-pole double-throw relay which has the contact rating that you need will do. None of the parts are critical. The "Thyrector" and Reset Ready light are kind of an optional item. Depending on your junkbox and scrounging ability, the whole thing shouldn't cost more than a couple of bucks.

I have mine between the color TV and the outlet now, and it has been working fine.

. . . WAØHKC

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Slower Tuning Rates for Older Receivers

After the oscillator has been stabilized, the front end sensitized, and the *if* crystallized, older receivers still lack a feature which makes the newer products attractive despite their cost. That feature is a slow, smooth tuning rate that allows one to tune across and with the signal rather than by it. Modern receivers have tuning rates varying from ten to 25 khz per revolution of the dial. In addition, they are free of backlash and have that smooth-as-velvet feel. Touch is part of what sells the browsing ham on the display model in the radio shops.

A couple of years ago, W7ZC/W5CA published an idea for slowing down the tuning rate of the Drake 2-B. Basically, he mounted a Jackson Bros. drive externally on the panel of the 2-B, using the holes already there for panel screws. Thus, he could replace the original dial whenever he sold the receiver without leaving any tell-tale signs of his modification. To add the drive, all he needed were a plate to mount it on and some L brackets to anchor the plate to the panel. The idea is adaptable to almost any of the older receivers around and will give a truly modern tuning rate plus the backlash-free velvet feel that comes from ball bearing verniers.

Since there are still plenty of older receivers around just waiting for modification, the original idea could stand some updating. It had a couple of drawbacks. With the 2-B, for example, moving from 40, 20. or 15 to 80 or 10 meters means shifting the dial from one end of the scale to the other. It takes a while at 7 khz per revolution to do this. In fact, one could miss a ten meter opening while getting to the left end of the scale. Secondly, the W7ZC mounting precludes use of the tuning dial scale. Although calibration of the theorectically 40 khz scale was not accurate because the oscillator was not linear, the scale was useful for logging purposes when one needed to find a station again.

By revising the mounting scheme and chosing an appropriate dial to replace the original, it is possible to overcome both flaws. In fact, one could even add a logging scale to receivers not already having one. With a little practice, interpolation of frequency to tenths of a khz is possible and practical.

The first job is to find a dial that will permit the use of both the 6-to-l reduction and the straight-through features of the Jackson drive. That part is easy. The Galaxy-transceivers and the WRL Duobander use a dial which internally holds a Jackson vernier unit. If you order one or the other from WRL as replacement parts, make sure you order all the pieces and ask for the hardware. They didn't send the little 2-56 screws to fasten the straight-through dial to the vernier, but perhaps this was an oversight. The difference between the Galaxy and the Duobander dials is that the former has a logging scale already scribed on the outer dial. If your receiver does not already have such a scale, this dial just might fill the bill. You might also want to get the little plastic piece that serves as a setting marker. Since I have a 2-B, I ordered the Duobander knobs.

Before showing how to mount the new dial, I should warn that anyone used to a

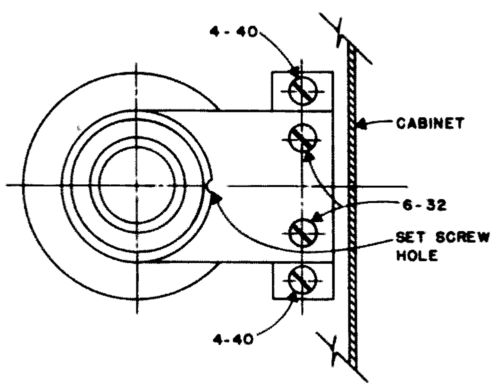
large tuning knob will find the two-speed dial awkward at first. It takes two fingers to turn, and the straight-through takes effort, since it has to move the little knob at six times the speed. It is a case of mechanical disadvantage. No more one-finger spinning from one end of the band to the other. But the whole point of the two speed dial is to be able to get to the part of the band which interests us and then to have really fine tuning.

A tip on tuning technique: don't tune overhand. It will tire you out in a few minutes. If the dial is low enough, rest the back of your wrist and hand on the table and tune underhand. The technique gives you smooth tuning and a precise feel. Your hand and arm muscles work only at tuning (which takes little effort) instead of tuning plus supporting the arm and hand (which takes a lot of effort). Little things make the difference between pleasant operating and tiring battles.

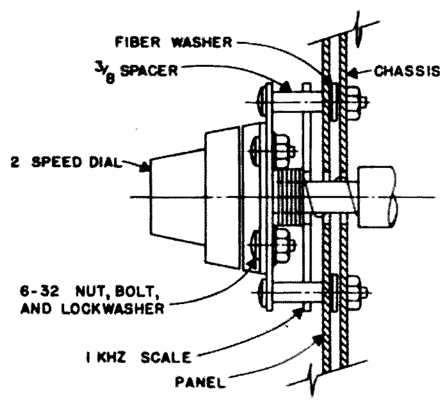
With the WRL dial, the whole assembly can be mounted closer to the panel than W7ZC described. The Jackson drive extends only about a 32nd beyond the dial. Using the sketches as a guide, mount the dial and drive on a plate the same diameter as the dial on one side, and as long as necessary on the other. The rounded side allows you to mount a calibration scale behind the dial, which is about the same diameter as the original 2-B dial. Since the plate is needed only to prevent rotational movement (the shaft does the main supporting job), it need not be heavy or large. Eighteen guage aluminum or slightly thicker bakelite is fine. For the 2-B, I cut a second piece that crosses the extension as a T in order to fit the panel holes available. Cutting the original as a T would work just as well.

The two-piece version has an advantage: it allows final alignment so that everything turns smoothly. It is a good idea to drill all screw holes in a slot shape and to let the screws and lockwashers do the job of holding things in place. No matter how carefully I measure, I am always a bit off with the drill. After getting fed up with the modification because the drive would bind, I realized that it wasn't lined up properly. The slots let me tighten the drive to the shaft first and then align the plates to it. Now the drive works as smoothly as without any load.

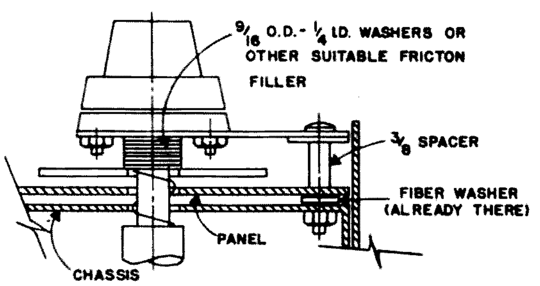
By using 4-40 screws (which fit through the sheet metal screw holes without reaming them out) and a bunch of extra nuts I had lying around, I solved the spacer problem. I



FRONT VIEW



SIDE VIEW



BOTTOM VIEW

Fig. 1. Mounting of plates and two-speed dial/drive as applied to the Drake 2-B receiver. Modify as required by the particular receiver being adapted for a slower tuning rate.

recommend 3/8 inch spacers, but 1/4 inch spacers with solid washers on top and fiber or felt washers against the panel to prevent marring will do as well. For other receivers, the size of the spacer will depend on how far out from the panel the dial shaft extends.

The shaft of the drive requires a half to 5/8 inch hole. I used the larger size because I wanted to keep the 2-B calibration plate. It is kept turning by a spring on the dial shaft pushing against the plate which in turn pushes against the dial. Since the Jackson drive does not push onto the shaft as far as the original dial, there is space to be filled up. Tubing with an inside diameter of 1/4 inch of either metal or plastic, or even a gob of electrical tape wound around the shaft will do nicely. The aim is to keep the plate turning with dial rotation but to allow freedom enough to reset it at will. I had a large number of 1/4 inch inner and 9/16 inch outer diameter washers which slid very nicely onto the shaft. Just choose the right number for the shaft length to be filled up. The advantage of the washers is that if something binds, the washers will turn against each other so that nothing is damaged. But under normal tuning, they turn as a unit because of their friction contact with the shaft and with each other.

The same idea can be applied in adding a scale to a receiver without one. The 2-B backs up the spring by a wide margin on the shaft. A washer against the panel, a spring, another wide washer, and then a felt washer with a drop of oil on it against the back of the scale plate will allow the plate to turn freely if something heavier on the friction goes between the plate and the drive. The gob of tape or a metal spacer with *dry* felt washers on either end will do the trick here.

For a professional look, paint the metal plate holding the dial black or to match or contrast with the receiver panel and knob. To impress your friends with your home brew ability and with the fact that you are one up on them with the same old gear, leave it a shiny aluminum or raw bakelite. The entire job is quite simple (about two hours work), but it gives the impression of immense complexity and ingenuity. And when you tune in your calibrator note and can hear it for a couple of revolutions of the

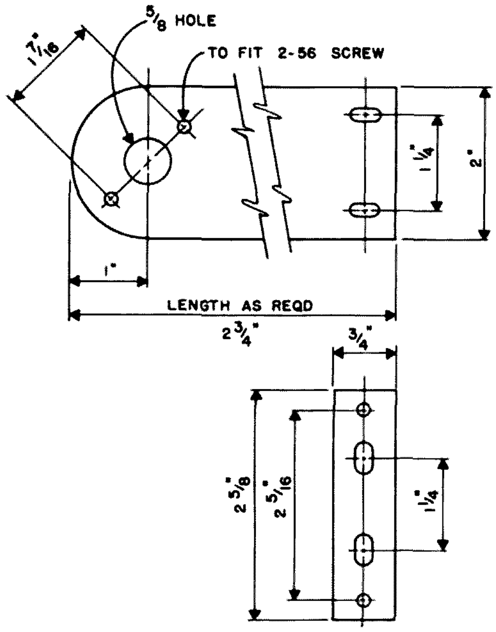


Fig. 2. Plates needed for mounting two-speed dial/drive. Adjust dimensions to fit particular receiver being modified.
Note: dimensions of slots not critical, but keep slots aligned as shown. Reversal of directions allows plate holding the dial to slip more easily as the dial is rotated. Lock-washers are essential in fastening the two plates together.

dial, you will amaze everyone, including yourself.

The real advance is in operating ease. With a slow tuning rate, you will hear stations that you previously passed over as part of the popping line noise and QRN. Now they have a tone that rises or falls depending on which sideband you are tuning. "You can't work 'em if you can't hear 'em", is an old saying, and we can add that being able to recognize a signal is half the job of hearing the hard ones.

An ultra-slow tuning rate is useless without a stable receiver. Some receivers drift faster than one could turn the knob of the new drive to follow them. That is another place the straight-through knob comes in handy. But stability comes first on the receiver modification priorities. Once you have achieved that or have a receiver like the 2-B, which remains stable even as it grows old, then you can concentrate on tuning rate and calibration. Here, the WRL knob and the Jackson Bros. drive really help. And this is the point where I came in.

....W4RNL

*David Middleton, W7ZC/W5CA, "Slowing Down the Tuning Rate on the Drake 2-B," 73. September, 1965, p. 44.

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Positive Identification of Calibrator Harmonics

The availability of low-cost high-frequency transistors and integrated circuits has made it possible to build inexpensively a 100 khz crystal calibrator with useable harmonics extending into the region of 400 to 500 mhz.[1] This means that you will have perhaps 4,000 or so crystal controlled signals available, all of which sound exactly alike when tuned in on a receiver. It is a real problem, therefore, to determine which harmonic of 100 khz is being received at any given time.

The usual method of identification

On the lower frequencies, when using a general coverage receiver, you can tune to WWV at some known frequency, and by carefully tuning away you can count the number of 100 khz harmonics tuned through until you reach the desired frequency. For example, if you wish to locate 7.0 mhz, you can first tune to WWV at 5.0 mhz, then tune higher in frequency until you come to the twentieth 100 khz harmonic above 5.0 mhz. This will be exactly 7.0 mhz. Of course, you must be sure of which WWV signal you are tuned to, but since the WWV transmissions are spaced at such wide intervals (2.5 mhz between the 2.5 and 5.0 mhz signals, and 5 mhz between the 5.0 through 25.0 mhz signals) there is little likelihood of making a mistake, even with a poorly calibrated receiver.

Possibility of error

With a limited-coverage receiver, such as the ham-bands-only type, you can tune to 7.0 mhz and perhaps you will hear a 100 khz harmonic at this dial setting. This is probably the 70th harmonic of 100 khz at 7.0 mhz, but it could also be the 69th at 6.9 mhz or the 71st at 7.1 mhz, and the indication would still be exactly the same.

At higher frequencies even a receiver with a wide tuning range will have the same difficulty. For example, say you build a receiver covering the range of 100 mhz to 120 mhz. A grid-dip meter will get you somewhere near the desired range, but the 100 khz calibrator will be useless for accurate calibration because you will be unable to positively identify any of the 200 or so 100 khz harmonics that you will be able to hear.

What is needed is some means of giving each harmonic some characteristic that would distinguish it from all of the other harmonics generated by the 100 khz calibrator.

A new method of identification

A simple way to do this would be to use two crystal calibrators. One calibrator would operate at exactly 100 khz, while the other would be adjusted to operate slightly above

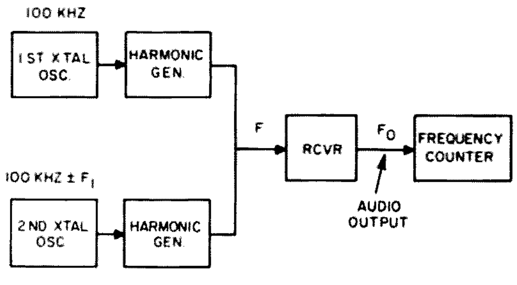

Fig. 1. Block diagram of proposed method of identifying 100khz calibrator harmonics. f=frequency of 100khz harmonic tuned to. f1=frequency difference in hertz between first and second oscillators. fo=audio output frequency in hertz.

or below 100 khz. Let's see what would happen if the second oscillator frequency were made 100 khz plus 10 hz, or 100.01 khz. The 100 khz and the 100.01 khz signals are fed simultaneously into a receiver that is equipped with an AM detector. If the receiver is tuned to 100 khz, there will be audio output signal, the frequency of which is equal to the difference in the two oscillator frequencies. In this case the difference is 10 hz.

Now we will tune the receiver to the second calibrator harmonic at 200 khz. The second harmonic of the 100 khz oscillator will be 200 khz, and the second harmonic of the 100.01 khz oscillator will be 200.02 khz. The difference frequency is now .02 khz, or 20 hz, which is the audio output frequency. The third harmonics of the calibrators would be 300 khz and 300.03 khz, which would give an audio output of 30 hz, etc.

As we go up in frequency the spacing between the calibrator harmonics becomes greater and greater, increasing exactly 10 hz with each consecutive harmonic. This could theoretically continue until you reached an output frequency of 50 khz, but the *rf* and audio bandwidths of most receivers would prevent going this high.

In order to determine which harmonic we are tuned to, we only need to measure the frequency of the audio output tone in hertz and divide by 10. Multiplying this answer by 100 khz will then give the correct frequency. After determining the frequency, you can turn off the oscillator with the 10 hz frequency offset and zero the receiver on the exact 100 khz harmonic for an accurate calibration point.

Now if you tune a limited-coverage receiver to 7.0 mhz, and with both calibrator oscillators running you have an audio output of 700 hz, you can be certain that you are actually tuned to 7.0 mhz. This is the only frequency, for all practical purposes, where you would have a 700 hz output frequency. 6.9 mhz would give an output of 690 hz, while 7.1 mhz would give an output of 710 hz, etc.

Technical details

The audio output frequency would have to be measured very accurately – at least to the nearest 10 hz or whatever 100 khz frequency offset you may be using. A frequency counter would probably be required to get accuracy of this order. This is no longer the hang up it would have been a few years ago. The introduction of inexpensive integrated circuits has made it possible to build a good frequency counter at relatively small cost.[2],[3] Some of the older tube-type counters are also available at surplus outlets at reasonable prices.

For our purposes the counter would only need to be capable of measuring the audio frequencies. The bandwidth of the receiver would be the limiting factor in most cases, and the 100 khz frequency offset would have to be set so as to get a useable output from the receiver when tuned to the desired 100 khz harmonic. For example, if the receiver bandwidth is 10 khz, with a 10 hz offset the highest measurable 100 khz harmonic would be the 1000th, or 100 mhz. With a 5 hz offset you could measure to 200 mhz, with a 20 hz offset you could measure to 50 mhz, etc.

The two calibrator oscillators must be accurately adjusted to their proper frequencies. In order to set one oscillator to exactly 100 khz, first tune the receiver to WWV at the highest receivable frequency where a steady signal can be heard. Wait until the tone goes off (the last two minutes of each five-minute period) and adjust the calibrator frequency for zero beat. Watch the receiver S-meter. When you are close to zero beat, the meter will begin to move back and forth at a rate equal to the frequency difference. Adjust the oscillator trimmer carefully until the meter moves very slowly and then stops. This will be exactly the 100 khz point.

The other calibrator can be offset the correct amount from 100 khz by using the counter to measure the beat note between it and WWV. For example, with a 10 hz offset you would adjust the oscillator for a 1500 hz beat note with WWV at 15 mhz (the 150th harmonic of 100 khz), or a 2,000 hz beat with WWV at 20 mhz, etc.

The 100 khz calibrator oscillators must be very stable. A transistor oscillator built with high quality parts and powered by a mercury battery would probably meet the requirements. A simple 100 khz transistor oscillator developed by the National Bureau of Standards has a short-time frequency variation of about three parts in 10,000 million, and a long-interval variation of about three parts in 1000 million.[4]

You would have to take care that the oscillators would be subjected to as little change in temperature as possible. Of course, if similar parts are used in both oscillators, it is probable that they will drift at approximately the same rate with temperature or

voltage changes. Thus the relative frequencies of the oscillators would not change, and the location of the received harmonics would still be correctly indicated.

Receiver stability would not be a determining factor in the accuracy of this system, as long as the calibrator harmonics could be held within the pass band long enough to enable measurement of their frequency difference.

Since this output frequency is the result of the calibrator harmonics beating against each other in the AM detector, a slight drift in the receiver local oscillator will not cause a change in the output frequency, but only a decrease in its amplitude.

Considerable thought has been given to the ideas expressed here, and I believe that their proper application would result in a simple, practical method of positive identification of any individual 100 khz harmonic heard on a receiver. I have not tested this system, however, mainly because I do not yet have a frequency counter. I don't think any great problems would be encountered, except possibly in the stability of the calibrator oscillators.

. . . K5LLI

References: (1) Ashe, "100 khz Thin-Line Pulse Generator," 73, February, 1968, p. 24. (2) Jones, "An Integrated Circuit Electronic Counter," 73, February, 1968, p. 6. (3) Suding, "A Cheap and Easy Frequency Counter," 73, November, 1967, p. 6. (4) Kiver, *Transistors in Radio and Television,* McGraw-Hill, 1956, p. 141.

Ham Tips: Save That Shielded Braid

Normally discarded shielded braid can be used as both a soldering aid and a heat sink. To utilize the braid as a soldering aid, dip the tip of the braid into some rosin flux. When desoldering components, heat them first and then touch the braid to the terminal. The mesh on the braid will act as a sponge and soak up the solder, leaving the terminal clean and solder-free.

When soldering to heat-sensitive components, use the braid minus the flux to conduct excess heat away from the component.

As the solder fills the braid, simply clip off the solder filled portion leaving fresh braid for future use.

Happy soldering!

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Adapting AM Transmitters to FM

In many parts of the country, one of the most popular bands today is two-meter FM. Most of the equipment is obsolete commercial equipment which has become available to the amateur market because changes in the standards necessitated replacement of the old wide-band gear with newer narrow band equipment. Some new FM transceivers designed especially for the amateur market are beginning to appear, but they are in the $300 range. If the amateur does not have access to obsolete commercial equipment or the inclination to adapt it to amateur frequencies, he may feel cut off from this interesting mode of operation. However, it is possible to get on the air experimentally by adapting existing AM equipment, as this article will show.

The first thing to do is to receive somebody else's signal. If you have a two-meter converter, you can do a passable job of receiving strong local FM signals by slope-tuning an AM receiver, or using an FM adapter which is available for some receivers. If you are receiving narrow-band FM, the product detector in a sideband receiver works very well.

Once you have heard something on the air, the next problem is how to talk back to it. If you have an existing two-meter AM transmitter, the likelihood is that it uses 8 mhz crystals. The easiest way to adapt this is to build a separate FM generator which produces a signal on 8 mhz and inject it at the crystal oscillator stage.

I converted one such transmitter by removing the AM modulator stages, and utilizing the sockets which were there to make a three tube FM generator. The diagram and parts values are shown in Fig. 1.Two 6SL7 tubes and one 6SG7 are used. These were selected simply because the octal sockets were already in the chassis. More modern equivalents can be substituted and only very slight modifications in parts values may be required thereby.

One 6SL7 serves as a high gain voltage amplifier for a high impedence microphone. There is nothing very special about this except that it has an *rf* trap in the input, which is a good feature to build into any high frequency transmitter. You may not need it, but *rf* has a nasty way of getting into the grid of the first tube without it.

The other 6SL7 serves as a Pierce oscillator and a PM modulator. You will note that there are two variable capacitors in the crystal oscillator circuit. The 25 pf capacitor is a vernier frequency adjustment for bringing the crystal exactly to the right spot. The 100 pf capacitor controls feedback. The two capacitors interact somewhat, and the feedback capacitor can actually be replaced in most cases with a small fixed mica of 20 to 50 pf, but if you put the variable in to begin with, you have the advantage of adjusting for optimum output even with a balky crystal. This may prove to be important, especially if you have to doctor the crystal onto frequency yourself.

Divide the desired output frequency by 36, which will place the crystal in the four megacycle range (146,940/36 = 4081.666). You can order a crystal with reasonable tolerance from a number of the firms who specialize in regrinding surplus crystals. The crystal I obtained proved finally to be slightly too high in frequency to net with other stations on the air. The 25 pf condenser was not sufficient to bring it all the way to frequency, so I used one of the old ham tricks. I opened the crystal holder and carefully drew a 1/8 inch circle with a lead pencil right in the middle of one side of the plate. Upon reassembly, this proved to have moved the crystal just enough so that the APC padder would pull it precisely zero beat with other stations on the air. I found a 20 pf fixed capacitor suitable for the feedback circuit, although some crystals and tubes might require as much as 100. Obviously, a crystal oven would be better than a "raw" crystal, if it is available.

The second half of this 6SL7 tube is a PM

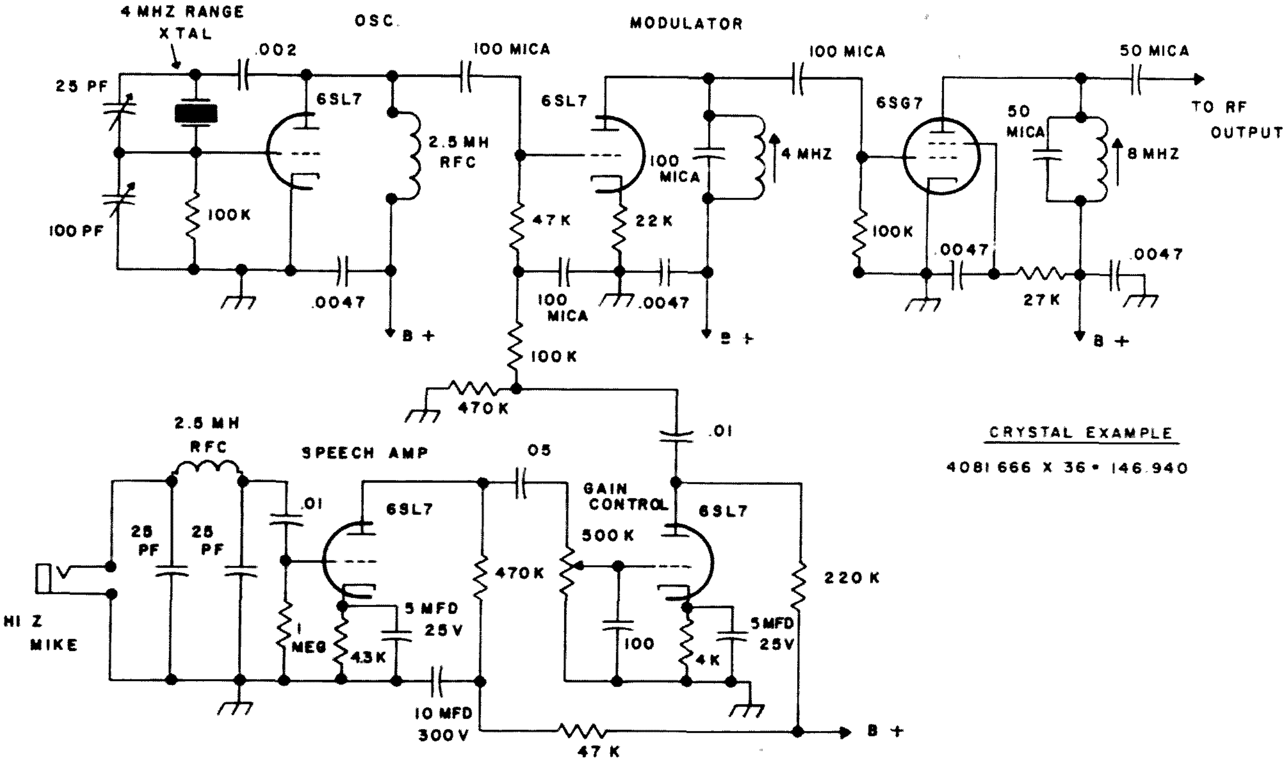

Fig. 1. Simplified 8 mhz FM generator and crystal substitute.

modulator. Do not bypass the 22K resistor in the cathode as this degeneration is important to the operation of this stage. I will not detail how this particular modulator works except to note that it produces almost as much amplitude modulation as phase modulation. The amplitude modulation disappears after the signal is passed through a number of saturated stages, which is one way of describing the hard driven multiplier stages in the typical transmitter which has to multiply a fundamental signal 36 times to get on the frequency. You can check with the sensitive *rf* meter at various stages along the line to observe decrement in the existing amplitude modulation. By the time you get to the final, there should be none at all.

This does require that the first amplifier after the modulator be a very sensitive high gain stage. I found a 6SG7 to be a very suitable tube for this purpose. Any number of miniature tubes will serve as well. The only thing you might need to change is the screen grid dropping resistor, which should be adjusted to provide the proper screen grid voltage as indicated in tube charts. One further question remains and must be left open to experimentation and to the taste of the operator. This is the question of audio frequency response. PM tends to sound tinny and some roll off of high frequencies in the transmitter or receiver is required to give a more pleasing sound. This can be most easily accomplished by shunting the grids and/or plates of the 6SL7 speech stages to ground with various size capacitors until you get the sound you want.

Obviously, this simple equipment is not likely to give you the best signal on the band, but then you haven't invested much in it either. If this mode of operation intrigues you and you want to carry experimentation further, the next thing I would recommend is a clipping or compressing circuit in the speech stages. This will help maintain a higher average deviation while restricting the peak deviation. This serves the same basic purpose as ALC in a side band transmitter or clipping and compressing in an AM transmitter, namely that it keeps the apparent percentage of modulation at the receiver high despite a wide variation in the actual level of sound input at the microphone. Again, just as with speech treatment in these other modes, excessive compression or clipping will distort the sound patterns enough to give the transmitter a very artificial sound. Taste and judgement are required, and for this, you need a good friend on the air who can give you a technically competent and honest report. This may be the hardest part of the whole operation to come by, but the FM fraternity is still new enough to include a great many experimenters, and you can probably find a sympathetic critic in your area if you look for one.

. . . WA4UZM

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CB Sets on Six

The band primarily used for local contacts is six meters. It is uncrowded and transmitters with very low power as well as receivers with modest selectivity are widely used. Lack of a simple station for six, however, keeps many otherwise enthusiastic operators away from this band. Having to build a converter for the station's present receiver, and an entirely separate transmitter for six is not very appealing to many operators. This article has the answer to their problem. Its subject is the conversion of the ordinary, everyday CB set to six-meter operation. Several advantages make it worthwhile: 1. the set already has the basic transmitter and receiver circuits and thus is easy to convert; 2. its transceiver type of operation is convenient to local contacts; and 3. it would make an ideal local vhf net monitor. If you were a CB'er turned ham and still had the old rig hanging around, you would have the added bonus of not having to find a CB set to convert in the first place.

The major requirement is that you obtain a CB set suitable for conversion. By suitable I mean that it should be a tube type rig and not a transistor one. Transistors in the receiver work at 27 mhz, but they may not work at 50 mhz. You would save yourself a lot of trouble by working with tubes. As far as test equipment goes, a vtvm and a grid dip meter are very helpful.

Conversion

The receiver section of the transceiver is converted in the following manner:

1. Tune into the CB band, tune up the *if* cans, and get the set working satisfactorily.

2. Resonate the *rf* and mixer coils to 50 mhz with the grid dip meter. Since the oscillator usually runs above the *if* frequency, adjust the oscillator to its proper frequency. The receiver is now ready to operate.

3. Tune up a signal on six meters. In place of the present tuning capacitor, if it tunes too great a range, substitute one with a smaller capacitance or remove several plates from the one in the set to give less frequency range. This, however, may not be desired, as one may wish to receive, for example, a MARS frequency, in which case he would rather leave the original tuning capacitor untouched. This finishes the receiver conversion.

The transmitter section of the transceiver is converted as follows:

There are two ways to convert the transmitter:

1. Leave the original oscillator in the circuit and resonate its output coil to 50 mhz. Insert a 50 mhz overtone crystal in the oscillator and you're finished. Overtone crystals, however, are more expensive than 8 mhz ones, and are usually not used in today's six meter rigs. On the other hand, use of an overtone crystal requires one less stage in the completed rig.

2. The second method of conversion and probably the most widely used is the use of an 8 mhz oscillator-tripler stage and a doubler stage. Refer to the circuit diagram for details. *Important:* Be careful not to leave out any bypass capacitors or any B+ decoupling resistors, otherwise the unit may fail to oscillate, or a stage may not work properly. An extra tube is required in this circuit, that being the doubler stage, which, as indicated, can be a section of a 12AX7 or a section of a 6U8. In addition L4 should be wound inside of L3 for good coupling. The

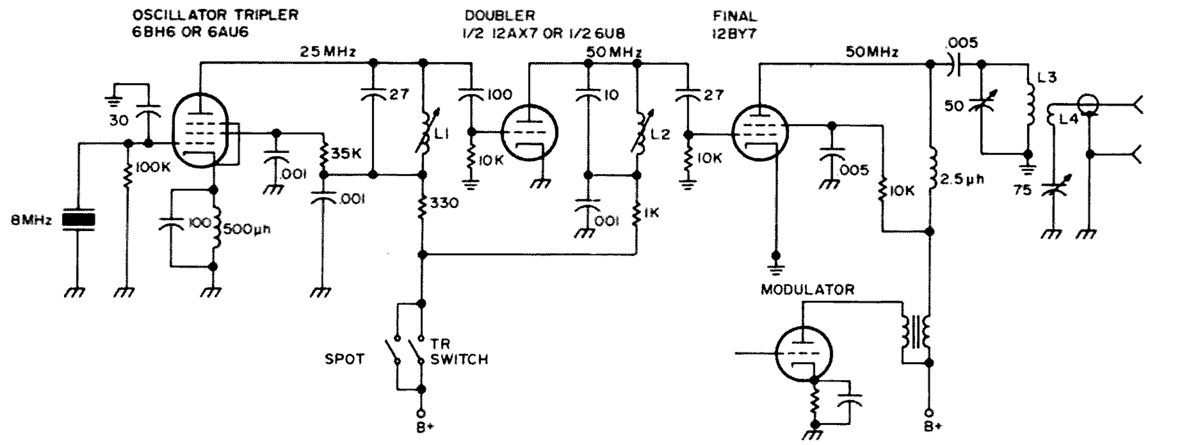

Fig. 1. Circuit diagram of the converter transmitter using the 8 mhz oscillator-tripler and the doubler stage. Coils L1, L3, L4 were already in the set. L2 was obtained from an old TV chassis. This circuit diagram may seem a bit incomplete, but since every CB set is different, the circuit must be broad enough to cover all models. As a result, some experimentation will be necessary to determine the proper coils to be used.

transmitter conversion is now complete.

Tune Up

Procedure: 1. Hook a No. 47 pilot lamp on the antenna jack or terminals.

2. Set each coil for the approximate frequency indicated on the circuit diagram.

3. Make sure the oscillator is functioning properly. This can be determined by listening to the signal in a nearby receiver. If there is a spot switch on the set it can be used to listen to the oscillator in the transceiver's receiver.

4. Put the *rf* probe of the vtvm on the grid of the doubler stage, and tune L1 for maximum *rf* indication on the meter (maximum pointer deflection). If an *rf* probe is not available, put one end of a 1N34 or an equivalent diode on the end of the vtvm's dc probe, and touch the free end of the diode to the circuit to be measured.

5. Place the *rf* probe on the grid of the final, and tune L2 for maximum *rf* indication.

6. Place the loading capacitor at minimum capacitance, and tune the plate tuning capacitor for maximum brilliance of the No. 47 pilot lamp previously hooked up. Increase the loading by increasing the capacitance of the loading capacitor, and then dip the current using the plate tuning capacitor.

7. If an overtone crystal is used instead of the 8 mhz oscillator-tripler, the transmitter should be tuned by resonating the oscillator plate coil to 50 mhz. The rest of the tuning is done as described above.

You now have a complete low power station for six meters. All that remains to be done is to hook up the antenna and a mike. I might add that there is really no need to have to switch the beam from the big six meter rig, that is if you have one; the set got out quite well on a simple dipole mounted on a stick of board. The total cost of converting the rig was nothing, as all the necessary extra parts were available from the shack junkbox. So if you want to have some fun on the band which is becoming more popular every day, try this simple conversion; you'll be glad you did!

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Proportional Control Crystal Oven

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When the ultimate in stability is required in an oscillator, a temperature controlled oven must be used. Until recently, ovens took the form of a box surrounded by a heating element and containing a thermostat. When the temperature is too low the thermostat closes, causing the heating element to come on. After the temperature rises to the thermostat switching temperature the heater goes off, allowing the box to cool down. This process continues with a full cycle usually taking a few seconds. One limitation of this system is having the heater either *on* or *off*. This means that at all times there is either too little or too much heat being applied. The result is a cycling of the box temperature as the heater goes on and off.

In the course of some uhf communications experiments, where a stable frequency and time reference were required, the oven described here was built. This oven is capable of much better temperature control than the old thermostatic type of oven. Proportional control is used to allow the correct amount of heat to be applied. Once the temperature of the oven reaches the correct temperature, the heater power adjusts to some level between all off and all on and stays there. If there is a change in the temperature outside the oven, the heater power will readjust automatically to keep the oven temperature constant. This type of oven is used in almost all precision frequency standards in commercial use today. Many ideas used in the design of this oven came from an article by W.L. Smith[1].

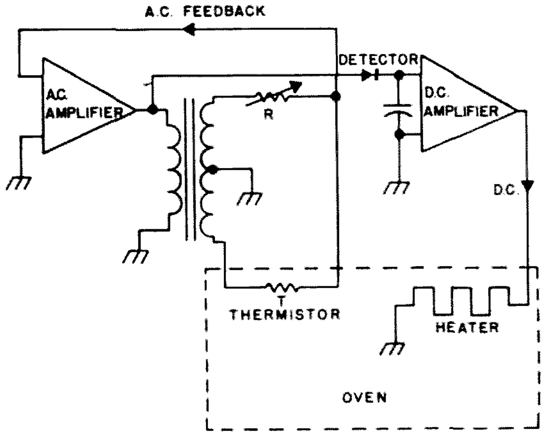
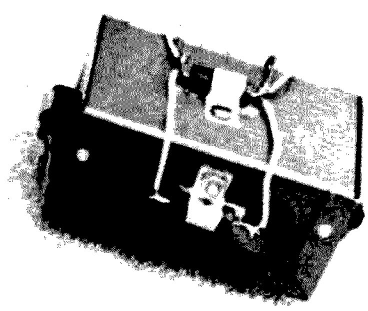


Fig. 1. Simplified diagram of oven temperature control.

An interesting aspect to this type of oven is its relatively low cost. With any kind of junk box at all, this proportional oven can be built for less than the cost of a thermostatic type crystal oven.



Vector board is used for the electronics. The 2 watt heater resistors can be seen clamped around the Minibox oven. When used, the oven is covered by insulating material.

Circuit

Operation of the oven control is best understood from the simplified diagram. The thermistor is a temperature sensitive resistor[2]. Mechanically, it is attached to the inside of the oven case. Electrically, a bridge circuit is formed so when the resistance of the thermistor is equal to that of resistor R, no voltage is fed back to the input of the ac amplifier. When the thermistor is cooled, its resistance increases. By choosing the correct phasing of the transformer windings, this will cause positive feedback around the ac ampli-

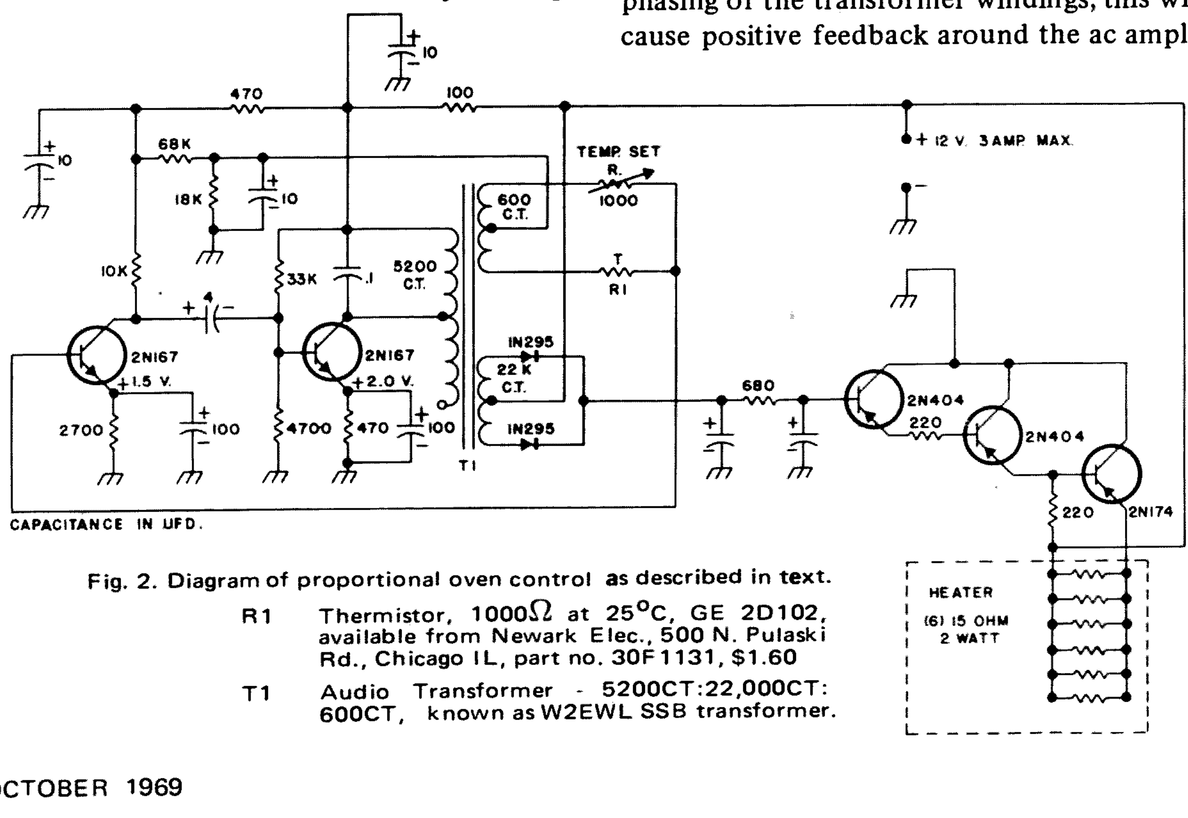
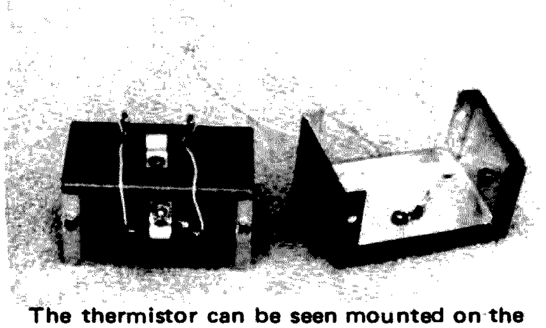


Fig. 2. Diagram of proportional oven control as described in text.

R1 Thermistor, 1000Ω at 25°C, GE 2D102, available from Newark Elec., 500 N. Pulaski Rd., Chicago IL, part no. 30F1131, $1.60

T1 Audio Transformer - 5200CT:22,000CT: 600CT, known as W2EWL SSB transformer.



The thermistor can be seen mounted on the inside of the Minibox oven. Paint was removed from the box where the resistors are mounted. An unpainted box would be preferable.

fier creating an audio oscillator. The voltage level from the oscillator is converted to a dc voltage by the detector. A dc amplifier raises the power level to a maximum of about 25 watts to drive the oven heater. As the heater warms the oven and the thermistor, the bridge is brought back to balance by the lowering of the thermistor resistance. If the thermistor resistance is lower than that of R, negative feedback occurs around the ac amplifier and no oscillation will exist. In this way, power is applied to the heater only when the temperature of the oven case is less than the desired temperature.

Between the point of no oscillation of the ac amplifier and full clipped oscillation, there is some voltage level that allows the heater to supply exactly the heat lost from the oven. Rather amazingly, this feedback arrangement will eventually find this balance point and bring the heater power to a constant level. Typically, this takes about 30 minutes.

The actual circuit uses two 2N167 transistors in the ac amplifier, and two 2N404's and a 2N174 in the dc amplifier. These particular transistor types were used because they were readily available. Almost any similar type should perform satisfactorily.

With the components shown, oscillation occurs at about 800 hz. A full wave detector provides a maximum of about 8 volts to the dc amplifier. This amplifier uses three emitter followers for unity voltage gain, with a current gain of about 20,000. The heater is built from six 15 ohm, 2 watt carbon resistors in parallel.

Construction

The layout is not at all critical. A heat sink of about 8 square inches area was used on the 2N174.

A standard 2-3/4"x2-1/8"x1-5/8" Minibox (Bud CU 3000 A) forms the walls of the oven. A 15 ohm 2 watt resistor is fastened by a cable clamp on each of the six sides. To provide good thermal contact, the side of each resistor is filed flat to a width of about 1/8". Transistor heat sink thermal compound is applied between the resistor and the Minibox. All six resistors are wired in parallel to form the heater.

In order to minimize the time required for the thermistor to sense the heater temperature, the thermistor is mounted inside the box behind one of the resistors. This gives a thermal lag of about 30 seconds and allows a reasonable warm-up time for the oven. The thermistor is carefully soldered to a ground lug that is then electrically insulated from the side of the oven by a mica washer. Again, heat sink compound is used to increase the thermal conductivity.

Operation

The only initial adjustment required is the phasing of T1. If oscillation does not occur, or if operation is very erratic, the 600 ohm winding connections should be reversed. Normal operation is indicated by a warm-up characteristic similar to the one shown in the graph.

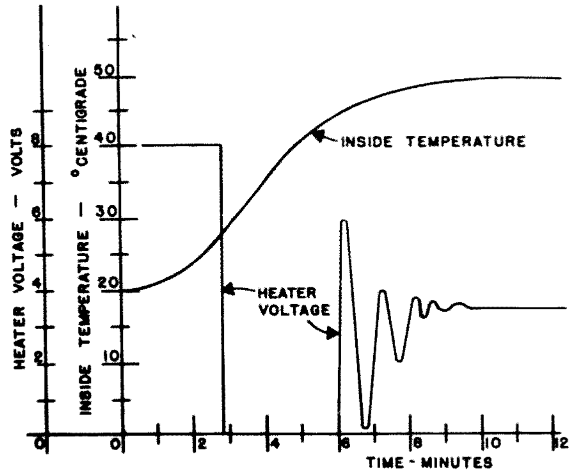


Fig. 3. Oven warm-up characteristics. Temperature measurements were made at the center of the oven.

The oven should be enclosed in an insulated box. This reduces both the heat loss and the magnitude of harmful transient events

such as cold breezes. A 1" to 2" layer of foam rubber or fiberglass is adequate insulation around the oven.

The contents of the oven should not touch the walls. Components inside the oven are best mounted by a thermal insulator such as foam rubber.

By adjusting R, the temperature in the oven can be set to almost any temperature above the ambient. The maximum temperature attainable is limited by the 25 watts deliverable to the oven. If the oven is well insulated from the air this can mean temperatures over 100° C so be careful or you may melt your new precision standard! Even above about 75° C some components may deteriorate. The oven takes about 30 minutes for the insides to warm up to a constant temperature. As shown in the graph, the heater power steadies up in about 10 minutes after having considerable overshoot.

...W2CLL

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1. W. L. Smith, "Miniature Transistorized Crystal-Controlled Precision Oscillators," IRE Transactions on Instrumentation, September 1960.
2. C. K. Klinert, "The Thermistor," 73 Magazine, November 1968, p. 78.

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A Crystal Filter Phasing Control

"They can make friends enemies, and enemies friends, by philters," *The Anatomy of Melancholy*, Burton, 1621.

Yes, even back in the 1600s, it seems they were using filters . . . er, philters, that is . . . to perform useful feats of magic. And what better legerdemain can be found in the modern communications receiver than a crystal philter . . . filter, I mean.

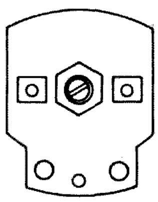

Fig. 1. Front view of the unmodified capacitor.

A crystal filter is useful in improving receiver selectivity because of its ability to pass one frequency while attenuating all others. It has another useful attribute as well – its ability to null out a specific frequency near the acceptance frequency. The use of a phasing control permits the null frequency to be varied slightly so that a near-by interfering signal can be eliminated without unpeaking the desired signal.

Although the control described was used in the "Second Chance" circuit,* it can be used in just about any standard *if* crystal filter circuit with untuned grid. The phasing control, which is simply a three-plate variable capacitor, is mounted and wired in place of the rotary "crystal on-off" switch on the front panel of the BC-348. The problem is – try to find a small variable with an insulated rotor shaft in any of the parts catalogs! After much looking, we became convinced that the only way we could get what we needed was to make one. The victim was a small APC variable capacitor with a short slotted shaft and locknut. These have been a drug on the surplus market for years and can be found very cheap. Figs. 1 – 4 show details of the modification.

*"A Second Chance Crystal Filter for the BC-348", 73, June, 1966.

Surgery is performed as follows:

a. Remove and discard the locknut. Next, with a knife blade or slender screwdriver, spread the four slotted parts of the shaft bushing apart and bend them away from the shaft. Flex them back and forth until they snap off.

b. Remove the collar from the tip of the shaft by filing a slot in the collar. It is mounted on the shaft with a force fit and can easily be pushed off once it has been weakened by filing.

c. Position the shaft so that the plates are

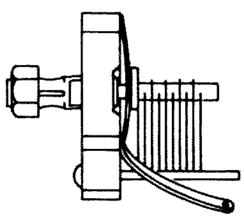

Fig. 2. Side view of the unmodified capacitor.

disengaged. Then withdraw the rotor assembly, taking care not to bend the three-legged flat shaft spring (one leg is the rotor connection terminal lug). File the rough surfaces of the shaft bushing on the front of the capacitor until the bushing presents a smooth bearing surface. Remove all but the two stator plates and the one rotor plate nearest the ceramic body of the capacitor by gently bending the plates back and forth until the soldered joint fractures. File or clip off the excess portion of the stator plate support pins and the rotor shaft.

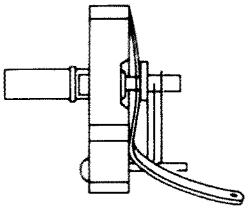

Fig. 3. Side view of the modified capacitor.

d. Prepare an insulating sleeve that can be forced over the rotor shaft to receive the tuning knob. The sleeve must be 1/4" in diameter and can be about 1/2" in length. We used a plastic test prod handle, cut to length, that merely needed enlargement of the bore down the middle. A No. 21 drill makes a hole that fits snugly over the metal rotor shaft. The tight fit is important because the sleeve must be forced on in such a way that the rotor contact spring is compressed and the proper spacing between the plates is maintained. Incidentally, the rotor spring may be flattened a bit to relieve some of the pressure it exerts. It need only make good electrical contact against the shaft shoulder when the plates are properly spaced. A small metal washer is used between the bearing end of the plastic sleeve and the filed surface of the bushing to prevent abrasion of the sleeve. To assemble, place the rotor contact spring in position, insert the rotor shaft through the spring and bushing, add the metal washer over the shaft, and force the plastic sleeve over the rotor shaft until the plates are properly spaced, noting that the spring is slightly compressed and making good contact with the rotor shaft. This completes the capacitor modification.

The phasing capacitor is mounted on the panel in place of the "crystal on-off" rotary switch. The original knob is re-used and

Fig. 4. Shaft details; (a) before modification, (b) after modification.

covers the two machine screw heads holding the capacitor in place. A small piece of black plastic tape may be placed on the back of the panel to cover the small hole which the switch anti-rotation lug occupied.

By bending one corner of the rotor plate, the capacitor will short-circuit itself when the plates are fully meshed. This will disable the crystal filter and provide normal low-selectivity reception.

One word of caution on connecting the phasing capacitor across the crystal – be sure you connect the grid side of the crystal to the stator. We inadvertently connected it the other way first and heard a beat note every time we touched the metal knob. It turned out that a local BC station, only a khz away from the *if* frequency, was getting into the *if* amplifier through the shaft insulation capacitance, tiny as it is! Reversing the connections cured this.

To understand how the filter is able to perform this dual role, a small dose of theory may be helpful. First of all, it is important to accept the fact that a quartz crystal has *two* resonant frequencies. One is the series-resonant frequency, at which the crystal offers almost zero impedance; the other, about 1 khz higher, is the parallel-resonant frequency, at which the impedance is very high. The variation of impedance as a function of frequency is shown in *Fig. 5.* At the series-resonant frequency, the crystal acts like a series-connected coil and capacitor. L-C combinations like this are useful as wave-traps to short-circuit undesired fre-

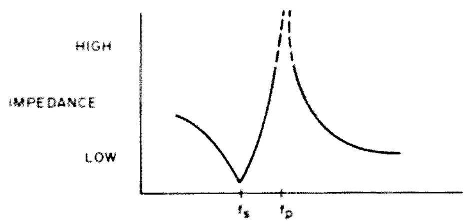

Fig. 5. The variation of impedance as a function of frequency.

quencies in the output circuit of a transmitter or in the input circuit of a receiver, for example. On the other hand, the crystal also looks like a parallel-connected coil and capacitor at a slightly higher frequency. The crystal in the grid circuit of a conventional crystal oscillator stage makes use of this configuration. Almost everyone is familiar with the fact that the frequency of a crystal oscillator can be lowered slightly by shunting a small trimmer capacitor across the crystal . . . a point to keep in mind.

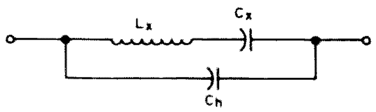

Fig. 6. The equivalent "black box" electrical circuit.

How can the crystal do two things at once? Let's take a look at **Fig. 6** which shows the equivalent "black box" electrical circuit. It is clear that Cx and Lx are arranged in a series circuit. However, Ch, representing the capacitance of the holder and wiring, is shunted across Cx and Lx.

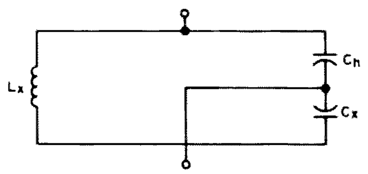

Fig. 7. The parallel resonant combination.

Redrawing it, as shown in **Fig. 7**, reveals the parallel-resonant combination. Considering the series-resonant condition, the presence of Ch has little effect on the resonant frequency; all it does is to act as an insignificant by-pass capacitor. However, in the parallel-resonant mode, Ch exerts a

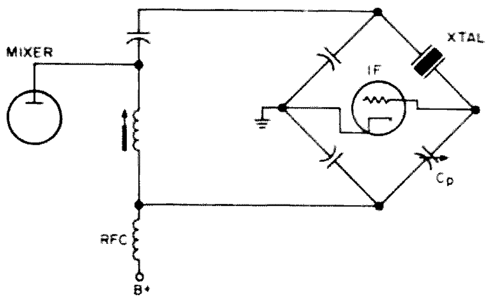

Fig. 8. Conventional bridge circuit with the phasing capacitor adjusted to balance out the holder capacity.

definite effect on frequency. If the value of Ch is increased slightly, the parallel-resonant frequency of the crystal will be lowered slightly.

In the conventional *if* bridge filter circuit, shown in **Fig. 8**, the phasing capacitor, Cp is adjusted to balance out the holder capacity Ch so the crystal will pass only frequencies at which it is series-resonant. Cp can be varied slightly either way from the balanced condition to indirectly affect the parallel resonant frequency of the crystal. Another way of doing this, especially in the BC-348 receiver, is to connect a small variable capacitor, Ca, directly across the crystal to permit small increments of the holder capacity as shown in **Fig. 9**. If trimmer Cp is set to balance out the holder capacity plus, let's say, half of Ca, then any change in Ca will cause Cp to have a surplus or deficiency of capacity as far as balance is concerned – exactly the same effect as if Cp was the variable control.

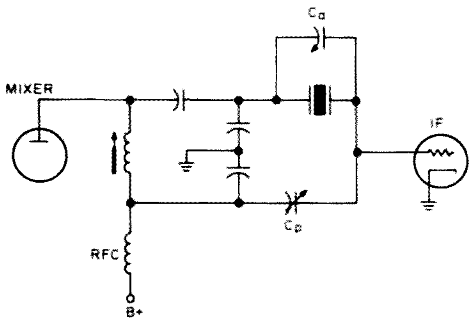

Fig. 9. A small variable capacitor is connected directly across the crystal to permit small increments of the holder capacity.

A word about *if* alignment is in order. The BC-348 selectivity curve with the filter out is as wide as the proverbial barn door. To make things worse, the *if* transformers are slightly overcoupled, making for a double-humped response curve. Originally, we felt pangs of sympathy for the designer who had to accommodate both the beacon band and the hf bands, with the result that the *if* landed in the bc band. But to deliberately broaden the selectivity that much! No doubt the military wanted a receiver that stood a chance of getting the message through when tuned roughly to a spot frequency.

The rough alignment can be made on background noise. With the bfo on and the

crystal filter in, advance the phasing condenser until it is half meshed. Then adjust the trimmer Cp until the noise has a tinny, ringing sound. Then peak up the *if* transformers (top and bottom) for the loudest noise with this characteristic sound. This completes the rough adjustment.

For the final *if* alignment, you will need a stable signal generator, preferably one that can be modulated. We found that the venerable BC-221-AK is perfect for the job. Also, you will need an ac voltmeter (say 0-5V) that can be bridged across the audio output as a tuning indicator. The object of the exercise is to find the exact series resonant frequency of the crystal. After this has been determined, the signal generator is parked on this frequency, and the final adjustment of all *if* transformers is made.

Couple the signal generator to the mixer grid through a gimmick condenser made by twisting two pieces of insulated wire together so they overlap for about one or two inches. The end of one wire can be stripped and wrapped around pin 5 of the 6SA7 mixer tube which is then replaced in its socket. Tune the signal generator slowly through 915 khz (with the modulation on and the bfo off) and carefully adjust the frequency for a maximum on the audio output meter. If you have hit it on the nose, the phasing control can be varied ±10 degrees rotation without appreciably affecting the output. Peak up the *if* transformers. Repeat the procedure to double check the alignment. A couple of hints: use no more coupling from the signal generator than is needed for a good output indication so the *if* chain won't be overloaded; also, short the antenna binding post to the ground binding post to prevent the reception of spurious signals which may interfere with the desired signal from the generator.

Before disconnecting the alignment setup, try testing the action of the phasing control in nulling out a weak signal near the peak frequency. Detune the signal generator about 1 khz higher than the alignment frequency. Slowly tune the phasing control until the output drops drastically. This adjustment is very critical and takes a fine touch. You should get at least 15 – 20 db attenuation as the signal drops in the rejection slot. Try other offsets from the alignment frequency; at least one setting should result in almost infinite rejection as the phasing control is tuned through it.

When operating the receiver in the "single-signal" mode, the phasing control is usually set so audio images fall in the rejection slot. That is, the bfo is set to a desired pitch that corresponds with the crystal filter peak frequency. Then, the receiver is tuned to the same pitch on the other side of zero beat. The phasing control is then adjusted to eliminate this signal (the audio image). In this way, half the potential interfering signals are automatically eliminated whenever the desired signal is tuned in on the crystal filter peak.

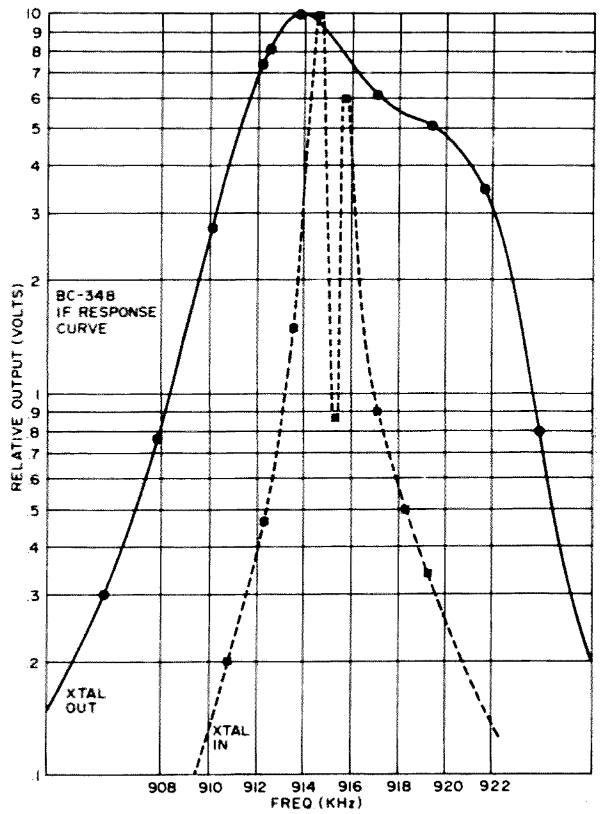

Fig. 10. The before and after if response curves.

The proof of the pudding is, of course, in the ability of the receiver to dig that rare DX out of the pile-ups. Using a homebrew converter which translates 10, 15 and 20 to the 80 meter band on the BC-348, we worked 20 new countries in two weeks. For the more scientifically inclined brethren, the "before" and "after" *if* response curves are shown in Fig. 10. Need we say more?

. . . W2LT

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Grounded Grid Filament Chokes

During the course of construction of my linear amplifier employing two type 4-400 A tubes, the market price of a 30 ampere filament choke was suddenly raised from about $9 to around $25. Whether this was due to the high price of copper, the enamel on the wire, or because a beautiful doll needed a new diamond, did not interest me one iota. It was high time for ingenuity to be summoned forth.

A look at the driving impedance of those tubes in this type of operation indicated a value of 300 to 500 ohms or thereabouts, which was halved for two tubes in parallel. This meant that the choke impedance at the lowest frequency to be used should have a value of, say, five times this in order to maintain a low *rf* loss through the choke. So we are then talking about a choke impedance in the order of 1000 ohms. One could wind this kind of a choke with his eyes closed unless he considered the current requirement of the tubes. This required a very heavy wire, size No. 8 or No. 10, and even then a good fraction of a volt could be lost between the filament transformer and the tubes. When a coil takes on these proportions, there must be a better way than rolling your own.

The solution was easy. Mount the transformer on insulators at least ¼" thickness, thus isolating it from all chassis grounds. Then connect the secondary directly to the tubes using wire of sufficient size to prevent any appreciable drop in voltage to the tubes. If you find that the transformer has an electrostatic shield, as did mine, disconnect it and let it float. The secondary center tap may be connected through a choke to ground by employing one of those small multiple-Pi types, but if you are particular about getting too much dc resistance in this circuit, and about wasting a good high impedance choke where it is not needed, then here is a place where a simply constructed device can be used. One of quite adequate characteristics can be made on a 1" diameter form about 3" long, wound with about No. 30 wire. A primary choke in the 110 volt line was wound in bifilar fashion with No. 24 wire, 1" diameter and about 4½" long. The heavy capacitance existing between primary and secondary, coming about either by direct coupling or via the core, indicates that there is little difference in the magnitude of the *rf* voltage on either winding and therefore the same amount of choke impedance is needed for each. Formex insulated wire was used on the bifilar and no indication of breakdown between adjacent turns has been evident in the three years of use. If preferred, two separate line chokes may be used in the primary in which case each can be physically smaller than the bifilar. A .01 mfd by-pass is used from each side of the line to ground, on the line side only. The above dimensions are approximate and have served well in my amplifier throughout 80 to 10 meters. They were duplicated more or less for another amplifier using 2 type 813 tubes. Of course a high quality coil form may be used, but in this case the circuit impedance is sufficiently low to allow an old broomstick, hammer-handle, or a dried out sapling to be used – even at 10 meters.

So the $25 with which I almost parted was used for much more important things. Come to think of it, I believe that I bought an anti-gravity machine from a door-to-door salesman.

. . W2IK

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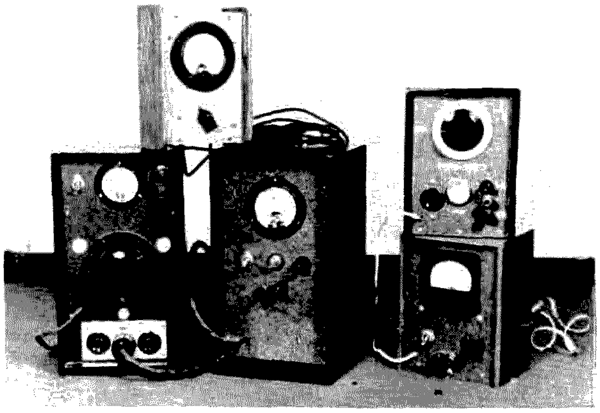
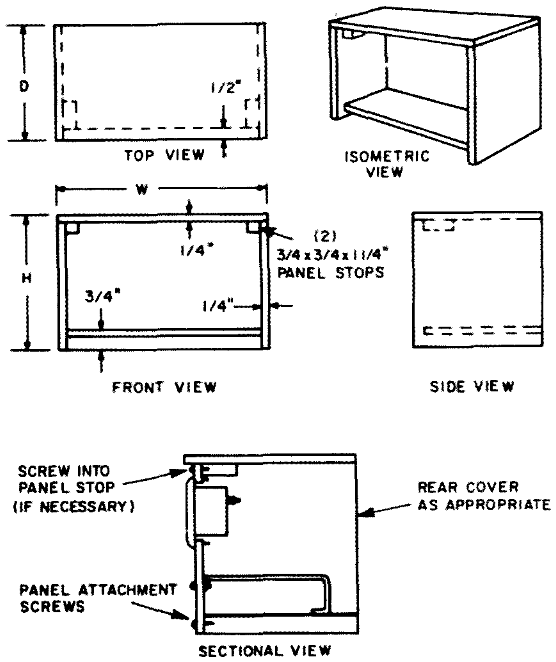
Equipment Cabinets with Style

Most experimenters and homebrew equipment builders settle for commercial cabinets, boxes and chassis to house their electronic creations. This article will describe a method of building cabinets that are simple and stylish and that can be built in a wide range of sizes. These cabinets have minimum cost and yet have the good appearance necessary to make your radio room and workshop look highly professional.

The solution to the cabinet problem is to build wooden cabinets like those shown in the photographs. Considerable development has gone into these cabinets. At this point I feel that maximum simplicity has been achieved without sacrificing utility and style.

The accompanying drawings and the text that follows describes a "type" of cabinet rather than a specific cabinet. If this type of cabinet is attractive to you, a little forethought is in order so that you may adapt the design to your own needs and to the most readily obtained materials. The width dimension will vary depending on the equipment that is to be housed. On the otherhand, perhaps you will want to standardize





on the height and depth of your cabinets so that they will present a uniform appearance. The quarter-inch plywood recommended for the sides of the cabinets will provide plenty of strength for even relatively large cabinets. However, if you have a source of another thickness or another material, it can probably be used.

Building Suggestions

The quarter-inch plywood sides and top and a three-quarter-inch pine or fir base materials appear to be an ideal combination of availability and usefulness. It is suggested that these materials be cut on a table saw if one is available. A table saw will provide square, relatively smooth edges that can be assembled without further furnishing. So little cutting is required that any friend who has a saw should be glad to make the pieces for you. Cut the sides and top from a single

piece that has been cut to the finished depth dimension. This will assure that the top and sides are all the same depth and that they will match perfectly when assembled.

The panel stops in the upper corners may be glued to the top of the sides as the first assembly step. Use white glue and half-or three-quarter-inch brads to fasten the various parts. Next, attach the sides to the base and, last, attach the top. Use the white glue generously, but wipe any excess off exposed surfaces with a damp rag. When the glue is dry – about an hour, the exposed surfaces should be sanded to eliminate any ridges between the sides and the top and to provide a smooth surface for finishing. A belt sander is handy for this operation, but hand sanding is easy and adequate.

The assembled cabinet should be sealed with shellac or a commercial sealer. It can then be spray painted using one of the quick-drying enamels or lacquers that come in spray cans. Build up three or four coats. Each individual coat should consist of several light sprays with special attention (resprayings) being given to any spots that tend to soak up the paint. Allow at least a half-an-hour between coats even though the label will claim that the paint "dries in minutes". The last coat should provide a high-gloss finish that will be an asset to any shelf in your house.

Nothing has been said about choosing the color for your cabinets and very little will be said. However, don't overlook the possibility of choosing one or more bright colors that will fit with your decor. I use a "mix-and-match" scheme. In the workshop, cabinets are "color coded". Power supplies are red and test instruments are black. The speaker that goes with the commercial receiver in the radio room is black like the receiver.

Panels may be metal, wood, "hardboard" or a plastic such as Bakelite depending on the needs of the equipment to be housed in the cabinet. Hard Masonite with a couple of coats of a sealer like Firzite makes an attractive looking panel that is easily worked using wood tools.

Panels for speaker cabinets can be made from perforated metal or with openings and grill cloth in the accepted manner. The back of a cabinet may be left open; closed tightly with wood or metal; or it may be closed using perforated metal or screening. Openings in the back and sides may be provided for cooling. Heating of the cabinet top can be lessened by cementing a piece of aluminum foil to the inside of the top.

The front panel can be mounted in most cases by using three-quarter-inch round-head-wood screws through the panel into the three-quarter-inch base. The panel stops at the top will prevent the panel from being pushed in. If added security is desired, wood screws can be used in the upper panel corners. If an extra long cabinet is built, it is recommended that an additional panel stop be installed on the inside of the top at the center of the cabinet.

Uses

Cabinets of the sort described herein may be used for many types of devices.

Power Supplies
Timers
Speakers
Signal Generators
Bridges
Clocks
Chargers
Meters
Receivers
Transmitters
Standing Wave Meters
Intercoms

The list above is just a fraction of the uses that can be found. These cabinets free the equipment designer from size limitations and, at the same time, provide him with a source of easily made cabinets that will enhance the appearance of his equipment.

...W1OLP

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VHF-FM: Part I

Advantages and Practices

When you operate, what do you want in a system? You may say reliability, quality of equipment, as well as ease of operation. Perhaps you have as insatiable thirst to tinker with equipment to get the absolute best performance. VHF-FM can satisfy all these requirements and more.

As you may know, VHF-FM is growing faster than any other mode. Why has such a relatively new concept enjoyed such popularity? Perhaps we can answer this by asking still another question. What is VHF-FM? Of course, you could say that you FM a VHF transmitter. But VHF-FM (or just "FM" from now on) is also an entirely different system of communications.

About 75% of all FM activity is operated from the mobile. The rigs are surplus gear taken out of commercial service (taxis, police cars, fire trucks, etc.). When you purchase these rigs, they come with all accessories . . . transmitter, receiver, power supply, mike, speaker, control head and cables, but less crystals and antenna. They seldom run over 60 watts, with most rigs running 30 watts or under. Antenna polarization is always vertical. FM deviation is usually wide-band (±15 khz) but there are a few scattered narrow-band outfits (±5 khz). The trend today is toward narrow-band operation, though. You can get a complete rig for as little as $25, but the usual price runs between $40 and $90 when obtained from a dealer. The possibility of obtaining the used equipment directly from the commercial user should not be overlooked.

As noted, just about all FM activity is crystal controlled and hence, operates on "channels." Because of accepted channels, repeater stations can be utilized. Such repeater stations, usually located on high ground with higher power, receive signals on one frequency and simultaneously retransmit the received signal on a different frequency. Going through a repeater, you can cover a 50 mile radius using just a one watt walkie-talkie. However, in speaking with other hams, I find that there is one big misconception about FM. It seems that quite a few people think that you *must* go through a repeater. Quite to the contrary. As a matter of fact, in southeastern New York, most FM activity is "direct," without the aid of a repeater.

Another advantage of channelizing is that most stations can, and do monitor. When an FM'er gets out of work, on goes the mobile rig. When he gets home, on goes the base station. After a while, you know when the different stations are monitoring. You are now approaching the reliability of the landline via ham radio.

Emergency communications is one of FM's strongest points. The fact that all stations are always on frequency and FM receivers are not susceptible to lightning or ignition noise provides for an extremely reliable situation. With some repeaters, if the commercial power fails, an emergency generator automatically kicks in. The abundance of mobile and portable equipment as well as the fact that much of this was designed originally for emergency use, gives FM the upper hand in most any emergency.

Operating procedure on channelized FM is somewhat unique. In some parts of the

country, the commercial "10-code" is used. This does provide for quicker QSO's, but this aspect of operation has *not* been used to any extent in the New York City area as well as many others. "CQ" is *never* heard on FM, since there is just no need for it. All stations are on frequency, so no long call is needed.

You might simply say, "This is WB2AEB monitoring nine-four," and that's it. If anybody wants to gab, they'll answer. Since the channels are well known, when referring to them you simply say the numbers to the right of the decimal point. Thus when you refer to 146.94 mhz you say "nine-four." When referring to 52.525 mhz you say "five-two-five."

Even where six-meters AM may reign king, two-meters is often where the FM ham stays. On a national scale, two-meters is also the most popular channelized FM band. 146.94 is the national two-meter frequency with other side channels such as 146.76. The national 6-meter frequency is 52.525 mhz. There is also a national ten-meter frequency and this is 29.6 mhz. There are about 300 hams on this frequency and more are joining every day. This band is popular because the skip comes in more often than the VHF bands. To get on ten-meters FM, you simply tune the rig down to 29.6 mhz instead of 52.525 mhz. The low-band rigs tune from 25 to 50 mhz often with few modifications.

As for UHF, the ¾ meter band is popular for your own "secret" repeater. To the FM'er, six-meters is called "low-band," two-meters is called "high-band," while the ¾ meter band is called "450" or simply "UHF."

As you can see, FM *is* different.

. . . WB2AEB

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Bring Back the Q Multiplier

Some fifteen or sixteen years ago, in another amateur publication of which Wayne Green was editor at the time, the Q-Multiplier was introduced. It immediately caught on big, and Heath began marketing a kit version which went through several models before it was recently dropped from their line. Except for its use in certain receivers as a notch filter, it has now just about gone out of style with the ham fraternity.

It's too bad that this has happened, because a Q-Multiplier can still do things no other circuit can for the same price. It is capable of a variety of functions which would otherwise require much more complicated and critical (and expensive!) circuitry. No other single circuit of such simplicity and low cost offers such a desirable combination of functions: 1. Single signal cw selectivity; 2. Tunable rejection notch; 3. Continuously variable selectivity; 4. Bandpass tuning.

How It Works

If all this sounds good to you, let's take a minute to examine the Q-Multiplier's principles of operation. Normally, more or less by tradition, the Q-Multiplier has always been set up to work with a 455 khz *if.* However, with proper modifications to the tuned circuit, it can be made to operate well at any frequency under 10 or 12 mhz.

The principle of the Q-Multiplier is similar to a suck-out trap, but considerably more sophisticated. When used to peak a single signal, the high-Q tuned circuit in parallel with the receiver's first *if* stage is regenerative because of positive feedback. This narrows the receiver bandpass. Effectively, the triode amplifies the high Q of the tuned circuit. A signal passing through the *if* at the tuned circuit's resonant frequency sees a very high impedance, and thus passes by the Q-Multiplier more or less unaffected. A signal slightly off resonance, however, is sharply attenuated, since it sees a low impedance, and is shunted to ground.

In the notch or rejection function, negative feedback is introduced by the second

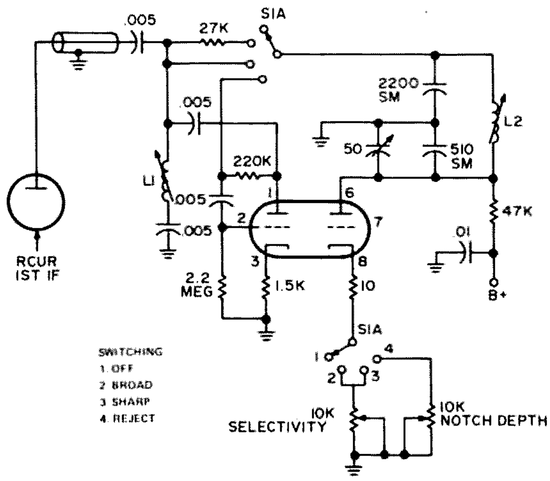

Fig. 1. The Grenell Q-multiplier. L1 & L2 can be either the Heath coils, if you rebuild, or Miller numbers 4414 and 4409 respectively.

triode, causing the impedance/frequency relationship to be reversed. Thus, a signal at the resonant frequency sees a low impedance, while those not at resonance pass through unaffected by the high impedance they see. The sole purpose of LI is to tune out the capacitive reactance of the coaxial cable used to connect the Q-Multiplier to the receiver *if*.

With the function switch in the sharp peak position, selectivity down to about 200 hz is available for CW reception. In some installations, it may be possible to obtain 100 hz selectivity.

How to Use It

The peak can be tuned across the *if* passband of your receiver to sort out a maze of signals very effectively. Using the Q-Multiplier in conjunction with a selective audio filter is just about the ultimate in effective CW reception. You really shave those signals close! I omitted the broad position in my installation, since the selectivity of my 75A-2 is set by a Collins 2.1 khz filter; but for those lacking a filter, the broad position is pretty effective for SSB reception.

In extremely crowded band conditions, it is possible to use the Q-Multiplier to separate SSB signals. With the selectivity advanced as far as necessary, carefully tune across the *if* passband. You'll find you can peak up the most essential voice frequencies of the signal you're trying to haul out of the mess. Under these conditions, the audio is very restricted, but you can copy! With a little practice, you'll find that you're able to slice away SSB QRM just as effectively as you can in the CW mode.

The rejection function should be familiar to most of you. It works just like a T-notch filter or the rejection function of the old style crystal filter. Tuning for the notch is very critical, and must be done slowly. It is also important to adjust the selectivity control for the deepest possible notch. This does not correspond to the setting for maximum selectivity. but falls around the middle of the control's range. The obvious use for the notch is the elimination of interfering heterodynes and adjacent CW signals. However, adjusted for a slightly broader notch, it will do a fine job of reducing QRM from adjacent SSB signals, as well. In the process, you'll probably notch a good chunk out of the signal you're trying to copy, but – again, with practice – you'll find it quite effective.

Building One

A few months ago, I picked up one of the old Heath Q-Multipliers from a local ham, tore it down, and rebuilt it in a corner of my 75A-2. The schematic shows the final circuit, except that it does show the broad position, which I omitted, for those interested. The original circuit used two pots – one for peak, and one for reject. Since the two functions cannot be performed simultaneously, I used only one pot on the panel, and put the pot for the reject position under the chassis, since it only needs to be set one time. I also changed the tuning capacitor from a 100 pfd unit to 50 pfd to obtain better bandspread within the passband. The 100 pfd variable tuned about 5 khz to either side of the center frequency. Those who will be using the broad position may want to retain the 100 pfd variable.

The Miller coils specified will work nicely in place of the Heath coils I used. The circuit layout is less critical than you might imagine, and point-to-point wiring is OK. Before making the connection to the plate of the first *if* amp, be sure your receiver is accurately aligned. With the Q-Multiplier off, adjust L1 for maximum signal. ***Do not repeak the receiver*** if, or you'll degrade the Q-Multiplier's performance.

With the tuning capacitor at mid-point and the Q-Multiplier in the sharp peak function, adjust L2 for maximum signal. Repeak LI with the Q-Multiplier off and L2 with it peaking about 3 or 4 times, as there is some interaction. Now check for the performance of the rejection function. The tuning point of maximum rejection will be just slightly different than that for maximum peak because of the capacity of the second triode switched in the reject function.

That's it. You should be ready to roll. You'll find the Q-Multiplier to be a valuable addition to your receiver. I hope these ideas will stimulate some new interest in this most useful and versatile gadget. Since Wayne Green was responsible for introducing it, it's most fitting that he should have a hand in re-introducing it!

. . . W8RHR

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Care of Antigua Star
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West Indies

Activation in VP2

Both in the American phone band and the DX section, hams continue to say the only VP2s that we have not worked are Anguilla and the British Virgin Islands. Meanwhile several hams would like to take along their rigs while holidaying in the Caribbean. Because of this I am writing an account of my recent DXpedition to the islands.

A request to VP2MY Frank, the managing director of Leeward Islands Air Transport (LIAT), for a complimentary flight to the islands was answered with an immediate roger, Frank is a patron of the Antigua Amateur Radio Club.

My next move was then to get a license and permission from the St. Kitts Government to operate on Anguilla island. Anguilla was a ward island of St. Kitts, but has since seceded in June, 1967.

A telephone call from my home QTH in Antigua to the telecommunication officer in St. Kitts resulted in my learning that the officer had QRT to Canada on business and that I should write to the Chief Minister of St. Kitts for license and permission.

A hurried letter to the Chief Minister was answered by the Minister of Communication requesting evidence of my British nationality before consideration of the license could be given.

Jerry VP2AC making first stop in St. Kitts to get government permission to operate on Anguilla Island. The rig here is an HW-32 with a Hustler vertical.

My scheduled time of departure was too short for correspondence, therefore it was necessary to call at his office in St. Kitts; and after routine inspections of my Antigua license, etc., I paid for my VP2K license and I was given the call VP2KC.

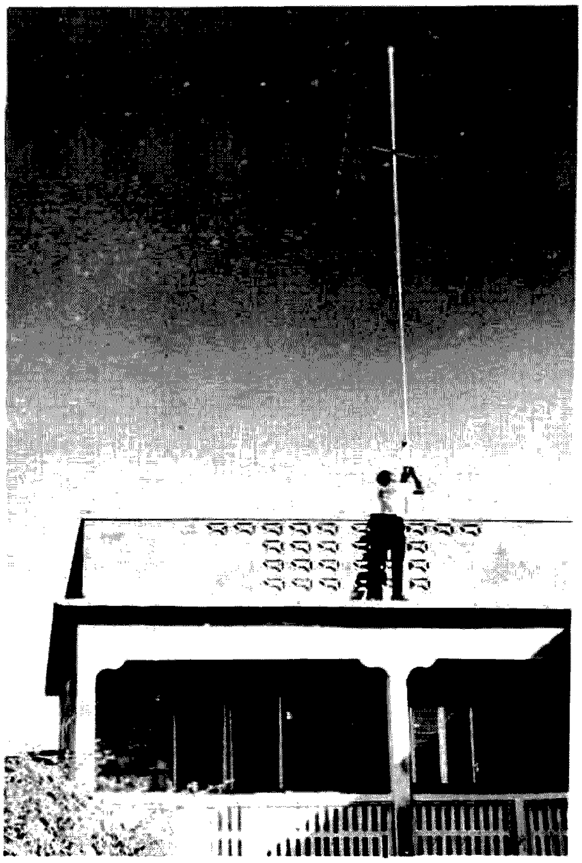
About 15 days before leaving on the DXpedition, Hurricane Inez destroyed my Hygain vertical which was slated for the trip with my Hot Water-32.

An immediate request to New-Tronics Corporation in Ohio for a Hustler vertical brought a donation of a 4-BTV Hustler which I received five days after the request via Amateur Radio Center in Miami, Florida.

On St. Kitts island it was necessary to transfer to a smaller aircraft which would fly to Anguilla, about 60 miles north. This created an immediate problem – the 6 foot by 1½ inches pipe and the vertical which was telescoped to 5 feet 8 inches could not fit into the small aircraft, and with only 15 minutes before QRT time, I hurriedly bought a hacksaw blade, quickly cut off 18 inches of the pipe, reduced the antenna to about 5 feet and scrambled into the six-seater.

On Anguilla island, I booked in at Lloyds Hotel, the most elevated location in The Valley – the capital or chief town. The hotel was the only place too that a generator could be rented at a moderate price – there being no electricity on the island.

Anguilla is a fascinating island in the northerly Leeward group of the Lesser Antilles in the tropical waters of the eastern Caribbean. It is a flat island stretching eel-like for approximately 15 miles. Prob-



Hustler antenna is being connected on top of the hotel room in Anguilla Island. From this location about 600 contacts were made, including WAC and 65 countries.

ably named L'Anguilla by the French who first owned the island, which in now populated by about 7,000 people.

The antenna was ready shortly after I arrived, and it was placed on the roof of the hotel. From here the sea was visible from all directions way out to the horizon. In the distance 12 miles away was the French-Dutch island of St. Martin silhouetted by the sun.

The generator was set into motion, voltage check – 118 volts ac. The HW-32 loaded okay. The American phone band was crowded and QRM plus plus. I gave several CQ's which resulted in no reply.

In the DX section the first station logged was VE3BWY Ham with 5 x 9 sigs both ways. Second day on Anguilla the first stateside station logged was W2RSJ and then the pile-up. All districts in U. S. A. were worked except the 7th district during the five-day stay on the island.

Several VK's were worked every day, including my good friend VK4HR, Harry, who was on the lookout for the DXpedition; and among the 600 contacts on Anguilla was the ever-popular PY2PS, Eva.

From this QTH WAC was logged and surprisingly the Russians were contacted long after 1300 Zulu unusual at this time in our neck of the woods.

We regret that several of the DL's were not worked when they were coming in 5 x 9 plus about 2000 Zulu, but the generator stopped and it took sometime before we got it going again. Then conditions to DL land had changed, and the DX section was practically dead.

But the American Phone Band was a bee-hive of activity. Several stations were logged before I found out that I was sandwiched between two other DXpeditions, VQ9AA Don on Aldabra and FH8JF Hosay on Comoro island who were working just about 30KC apart.

Tortola in the British Virgin Islands was the next QTH of the DXpedition, but before QRT from Anguilla I observed that the local government was preparing to install 220-240 volts AC in The Valley. The next DXpedition to Anguilla may be much more comfortable for the operator.

To get to Tortola from Anguilla it was necessary for one to enter St. Thomas in the American Virgin Islands if one wanted to travel by air. While booking for St. Thomas it was discovered that my certificate of vaccination against small pox was missing, possibly left in Antigua.

A quick check with the only doctor on the island and I was revaccinated and given a certificate. In St. Thomas swift motor vessels and sea planes travel to Tortola, and to cut down traveling expenses, I packed the equipment in one of the vessels, and I was happy I did because I made a good study of the islands. I was amazed with their number and proximity. Here, there and everywhere were islands – Virgin Gorda, Anegada, Jost Van Dyke, Salt Island, Peter Island, Cooper Island, Norman Island, Marina Cay, Guana Island and many other islands ranging down to mere rocks rising from the blue waters. We sailed through Sir Francis Drake's Channel and tied up to the pier in Road Town Harbour.

The Tortola customs insisted that I pay duty on my equipment, but after some

explanation, I was allowed to pass through free of duty, pending some further investigation into my true mission.

On Tortola island, the Administrator, the Telecommunication Officer and the Inspector of Police gave me every assistance to get up the station. Thanks to to the Chief of Police in Antigua, Mr. Edmund Blaize, who sent letters asking for assistance and recomendation to the DXpedition. Mr. Blaize is a patron of the Antigua Amateur Radio Club.

The capital Road Town is a true valley completely surrounded by high mountains with an opening from the sea. To my mind this location was not ideal for a DXpedition – and I had decided to QRT to Marina Cay three miles away, but this would necessitate renting another generator for electricity – and enough money was not available for this, therefore I set up station in Road Town, and after 5 days operating here 560 stations was logged.

Tortola is the largest island in the British Virgin Islands with a population of about 8,000 people who have a strong inclination to be Americans, and are greatly influenced by their neighbours, the American islands St. Thomas, St. Croix and St. John.

First station logged from Tortola was YV2GT sharply followed by W1CLX and the pile-up bounced in over the mountains with amazing 5 x 9. Another popular YL logged in the pile-up was W1RLQ Grace who was worked at all the stops as well as from the QTH in Antigua.

Several Africans were worked every day after 2000 Zulu. The SM's were constantly logged and several HB9s were buried in the QRM. My good friend VP7NA Harold from the Bahamas was logged and we chewed the rag for a few minutes. All the Canadian districts were worked, and at the end of the Tortola operation WAC was again logged and 65 countries worked.

My QSL Manager WA4AYX Pete was constantly monotoring the operations through the islands, and the courtesy of the American hams was indeed commendable – while my QSL Manager and I were in QSO, they were all QRX until he was through.

And another commendable factor of the Stateside hams was the orderliness in which the boys came in when called in districts. Being transcieve I had to call in the stations by districts because of the tremendous pile-up.

My next stop was the island of Barbuda, and I had first to return to Antigua. Flights to the ward island 40 miles north of Antigua were all booked until one week later. Having only 25 more days of vacation I decided to move immediately and boarded a fishing vessel for Barbuda.

I was the sole passenger and after six hours' sailing we anchored in the placid lagoon of Codrington Harbour.

No electricity was available on the island and therefore I set up station at the Police Department with the kind permission of the Chief of Police in Antigua.

The police generator delivered 230 volts ac and we stepped down the voltage to 116 volts to power the Hot Water – 32. The police officers, some were my schoolmates, helped me get up the antenna. We went on the air immediately and first worked K2CWQ who is believed to be the first ham to work Barbuda; there being no record of a station being set here before.

Station K7TNE Meg was worked and this was the first and only station logged in the Seventh District through the entire DXpedition. After 5 days of spotty operation, 480 stations were logged with a new bird FP8AC on St. Pierre Island. At this moment a YV5 broke on the frequency and wanted to take over operation, but I would have none of it.

Barbuda is a very flat island with highlands up to about 200 feet in the northern section of the 62 square mile land. It is almost all of coral formation with a very large lagoon on the western side which leads to the main and only village, Codrington, where 1,200 people live like one big family.

It is one of the few islands where wild deer are still found, and the only island in the Caribbean with beaches of pinkish-white sands stretching for more than 15 miles.

My QSL Manager Pete has been and is still handling the QSL cards for Anguilla, Tortola, and Barbuda DXpedition.

My next DXpedition is being planned for Dominica (VP2D), St. Lucia (VP2L) and St. Martin (FM7).

. . . VP2AC

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Melbourne, Florida 32901

The CR Beam

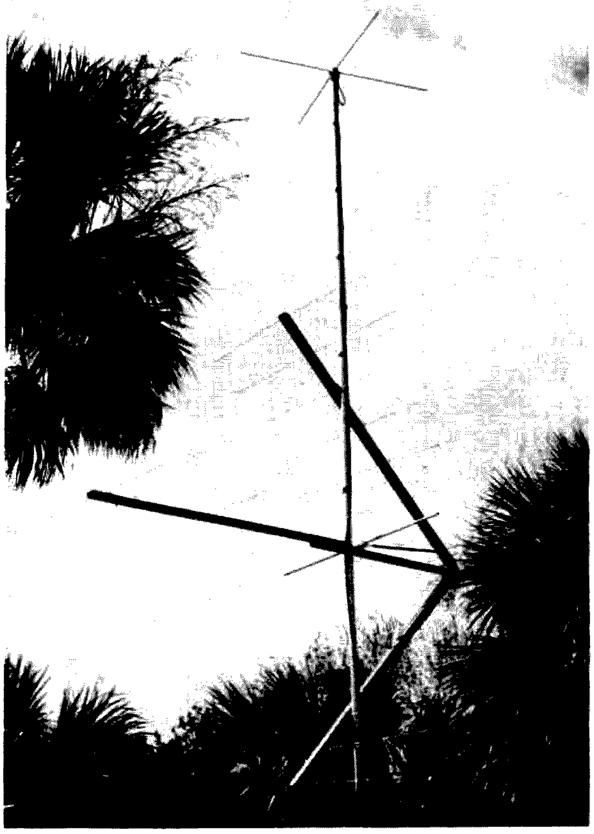
It seems now, that my two-meter antenna has been up there for ten years, but on checking the log, I find it has only been a little over two. Of course, it may only seem that way because, in this neck of the woods, a lot of hurricanes and high wind conditions have tested their strength on this rather frail looking piece of gear. I am happy to report that it's still doing what its supposed to, in spite of them all!

The closest we have come to disaster was last fall. During a three-week down-range trip (I was working at Cape Kennedy as a cameraman at that time) Melbourne was sideswiped by a small, freak, tornado. On my return I found that the two-inch, thick-walled aluminum conduit extension mast that supports my rotor and hf antennas (and which is guyed, top and bottom) at the top of my tower was bent at a forty-five degree angle from the vertical, leaving the antennas facing the ground but otherwise intact.

This small twister had demolished quite a bit of valuable property in our town, including a beautiful tri-band array at the QTH of W4JHM, only a hundred and fifty yards west of us. It took me exactly thirty-five minutes to saw off the five-foot bent portion and get everything back up in the air. So much for the ruggedness of this kite.

As you will see, this antenna, even if you don't scrounge (as I do) but buy all of the component parts, will cost almost nothing. As for efficiency, I'm sure there are antennas you can buy or build that will give you more gain, greater front-to-back ratio, etc. However, for simplicity, ruggedness, ease of construction and compactness, plus broad bandedness and, last but not least, cost, you will have to go far to beat this one.

One more word on efficiency. I, like most of our breed, do not have access to high-priced lab equipment, but I do have, as you do, friends and fellow hams. K4JKX



lives about fifteen miles away. Using a nineteen-inch ground plane at his QTH, he was copying me at less than one half S unit on his SR42, while I was transmitting on a turnstile at about fifty feet of altitude. After switching to my little CR beam, he reported S 5-6, a gain of 4½-5 S units. If this isn't good enough performance for you, you'll have to experiment with one of your own. So, to work!

The basic materials for this rig are a ten-foot length of 3/4 or 1-inch aluminum or steel mast, two six-foot and one eight-foot lengths of one-by-two-inch cedar, a 100-foot coil of aluminum clothes line, (you will have about 25 feet left over) 40 inches of ½-inch aluminum tubing, and assorted bolts, nuts and insulating material. The 3/4-inch or 1-inch aluminum tube will be the mast (I put my turnstile for local ragchewing, on top).

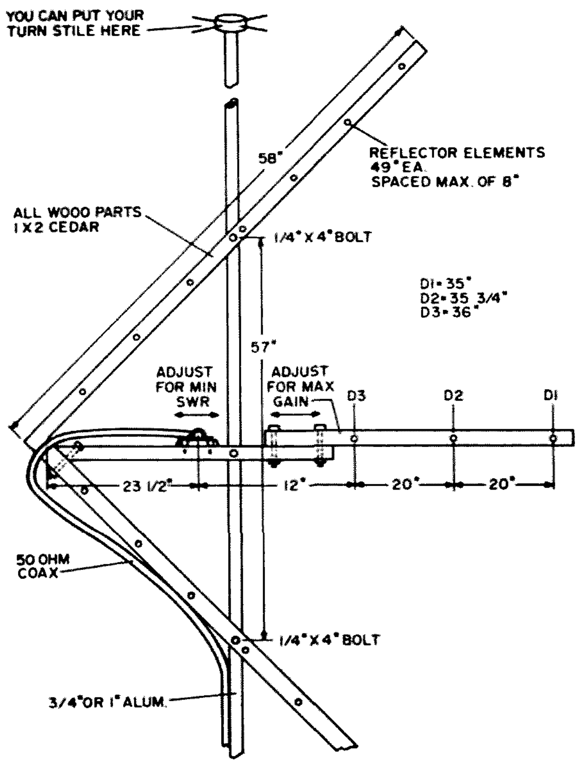


Fig. 1. Corner reflector construction.

Drill holes in the tubing for bolting the 58-inch lengths of cedar, approximately 28½ inches either side of center and drill the same size holes (to pass ¼ x 4" bolts) in the 58-inch cedar strips about 39½" from one end of each strip (the ends that will form the apex). Drill holes, for force fitting the aluminum clothes line reflector elements in the cedar strips every 8 inches, measuring from the apex or corner end (you may put an additional element at the apex if you wish – I never got around to it). Straighten the clothes line by anchoring one end to a tree or other firm object and tugging gently but firmly with a car on the other end. You will wind up with a nice, straight piece of aluminum wire from which to cut your 49-inch reflector elements. Force the elements into the holes in the cedar strips until they are halfway through. I put a drop of weldwood glue on each side of each element and have never touched them since.

An important thing to remember at this point: don't put the reflector elements in until you have layed this out on the ground with the reflector frame strips loosely bolted to the mast, because you will have to drill another hole in the mast for a bolt to support the boom. The boom will be made in two pieces so that the director elements will be in line (horizontally) with the driven element, and the driven element in line with the apex of the corner reflector. To have these parts line up accurately, the bolt hole will have to be a bit below the center and it is much easier to do this with the whole assembly laid out on the ground. Once you have your holes drilled and are sure of your alignment, you may proceed with the assembling which will go rather quickly.

For final assembly, I fastened the mast up vertically and bolted the reflector frame to it with the elements glued in place and ran a thin bolt through the back end of the boom and the reflector frame. I put the drive element on last. Make sure that you bolt the wood strips all on the same side of the mast. It looks awfully funny the other way.

Finally, the driven element – I must say at this point that I make no claims for originality concerning any portion of this rig – and the drive element is no exception. However, in self defence, I have found that combining these various components in this particular way may be a bit original. The driven element has been written up before, under different titles. Finding it to be all it was ever claimed to be, I am using this feed on all of my antennas. Construction is simple, quite weather proof and gives me an SWR of 1.5-1 across most of the band. The whole element consists of a half wave dipole of ½ inch aluminum tubing fed by a transformer consisting of a ¼ wave piece of RG8U coax-shorted (center conductor to outer braid) on each end and well taped, after which the outer insulation is cut at the center. The shield braid is cut at the center and separated by about 1 inch and soldered to about a four-foot length of RG8U. One side to the braid and the other to the center conductor of the feed line. All joints are taped with plastic tape to weather proof and then the ¼ wave piece is slipped into the ½

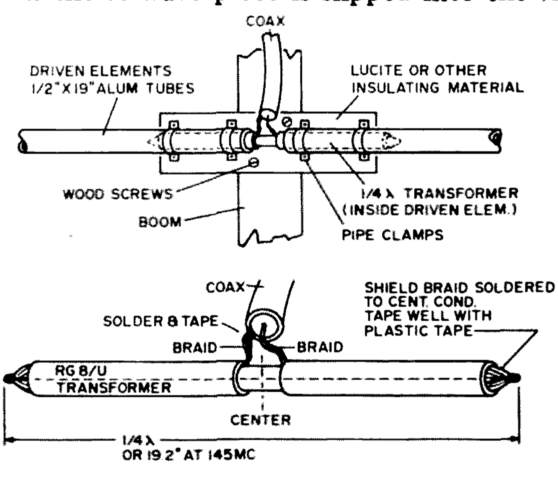


Fig. 2. Details of driven element.

wave dipole leaving the four-foot section of coax for feed line.

You can solder your coax feed directly without the four-foot piece, but I like the convenience of a short length for testing and pruning purposes. When I built mine, I made each driven element about 19 3/4 inches long and mounted them on a piece of scrap ¼ inch plexiglass. Any good H. F. insulating material will do, even bakelite, but I prefer the high polish of the plastic for our salt and weather conditions. After mounting the driven element, I prune it to 145mhz using my grid dipper, an impedance bridge, and a cheap (95c) tubing cutter. The final touch up was made by sliding the element back and forth for lowest SWR and doing the same for the directors for highest front gain. The sketches should make everything clear.

That about does it. I'm sure that if you follow the pics and diagrams reasonably closely, you will wind up with as good a signal squirter as mine. Good hunting on "2" and "73"s.

. . . WB4FDQ

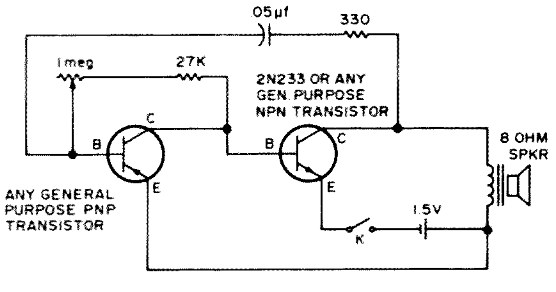
References

"Infinite Impedance Match," 73, March, 1963 p. 20.

1965 ARRL VHF Manual, pp. 208 and 225, Figs. 9-31.

A Simple Code Oscillator

This code keyer has a wide range of frequencies to please the tastes of anyone who wants to learn the code. It uses very few parts and can be housed in the base with the key. The circuit uses two inexpensive transistors, one a PNP, the other an NPN; almost any type can be used.



A simple code oscillator

The unit is assembled on a 5 x 2½ inch piece of phenolic board. All the parts except the 1 megohm pot and 27 k resistor are mounted on the underside of the board.

Ray Ezelle, WA8YWK

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Box 303
Springdale, UT 84767

The ARRL Board and Amateur Radio

The Annual meeting of the ARRL Board was held in New Orleans on May 2, 1969, following several days of informal gatherings, committee meetings and socializing.

A serious attempt was made in the early '50s to hold every other Annual meeting in a place away from the shadows of the Ivory Tower in the Hartford area. Denver '54 and Montreal '65 are two locales of this meeting of the Board and the HQ entourage. There may have been other travels for this important (to amateur radio) affair where the fate of AR may be decided or at least influenced. However, most such meetings are held near HQ.

Present in New Orleans were fifteen directors and one vice director acting for his ailing director. Also present; a clutch of VPs; the General Manager-Secretary, the Treasurer and four vice directors (who did not get their expenses paid by ARRL) and a bevy of HQ personnel. Missing from the roster was ARRL's Public Relations Counsel (Item 101 of the 1966 minutes requests that a study be made of retaining PR counsel to attend all Board and Executive Committee meetings). Also missing –any representative of HQ's technical staff.

In reporting the activities of this meeting, material has been placed in associated areas, each listed in a tentative "order of importance" related to the present and future of both AR and ARRL. References are made by Item number and are not in the order found in the mineoed minutes prepared and distributed by the Secretary. Category headings were selected by this reporter.

Public Relations–A motion (Item 12) passed (11-4) that a study of, and recommendations be made for, a form of Field Organization which will provide contact between HQ and those members whose interests do not presently coincide with the interests of the Communications Dept.

What ever became of the request for a Field Organization setup–made by a previous Board a few years ago? Such a F. O. is long over due and badly needed to bring ARRL to the field!

After extended discussion, during which it was almost tabled, Item 39 requests (13-3) that a suitable publication be written by ARRL (after consultation with reading specialists) directed at the 12-16 year old group.

The idea is commendable. The negative votes are inexcusable.

A unanimous affirmative vote (Item 41) instructed the General Manager to take steps leading to the addition of an "introduction to Amateur Radio" course to high school and adult education classes.

This too is an excellent idea, but it will require heavy follow-up.

A unanimous vote (after discussion–Item 44) instructed the General Manager to periodically publish in QST information on ARRL's structure, including directors and SCMs, and to include a glossary of ham terminology.

This will be excellent PR and should enhance relations between ARRL and the AR body. All too few licenses know what ARRL is all about and many care less! Such indifference does not always involve personalities but is often related to ignorance of basic ARRL concepts, aims and goals. With new blood coming into AR, and with the ever expanding fields of endeavor in AR, ARRL should do a better selling job of itself.

According to Item 60, a unanimous vote requested the General Manager to have the PR Counsel prepare material for distribution to prospective members that will convey the tangible value of ARRL affiliation to the individual.

This idea, together with that immediately preceding it, may make ARRL membership more meaningful to amateurs. This PR work is in the right direction since HQ has failed to do its iob on this. Follow-up is necessary, if it is to succeed.

Item 81 states that W4GSX will be presented with ARRL's 1969 Technical Merit Award for his analysis of typical amateur antennas using modern computer techniques.

W4GSX's work will be awaited impatiently by many who have been looking for a typical antenna! Maybe he has the answers!

This reporter (the originator of ARRL's Merit Award) is always delighted and proud to see this Award made as some times the Committee has passed it over being unable (?) to find anyone worthy of the Award. It should be noted that the original motion creating this Merit Award included HQ actions to properly circulate news of the Award to non-amateur media in order to obtain the greatest possible PR from the amateur's work, which resulted in his Award. Such PR has not been properly done and much of the value in the non-amateur PR world has been lost.

The General Manager was requested (Item 87) to "continue an advertising campaign in magazines which might be read by individuals who are likely to have an interest in becoming radio amateurs, in an attempt to attract more individuals into the amateur service."

Such advertisements should be of great value to AR and to ARRL. The word "continue" implies that such advertising has appeared. This reporter would be grateful for clippings of such ARRL-placed ads as so far they have escaped his notice with one exception.

Defense of Amateur Radio Frequencies–The Dec. 31, 1968 ARRL financial report indicates under "Reserves–for defense of amateur frequencies–$62,413.52."

This is the balance of a $100,000 fund furnished ARRL's President Hoover, W6ZH, some

years ago and which had become depleted with PR studies and other expenses.

Item 30 states "on motion of Mr. Chapman, unanimously voted (Messers Spencer and Thurston *abstaining* [italics supplied–ADM]) that, in view of an announcement of a forthcoming conference of the International Telecommunications Union, the Board replenishes the $100,000 fund for the defense of amateur frequencies."

Although little has been heard from the original $100K or the nearly $37K spent to date, this fund could become a vital weapon in the battle to preserve and protect our frequencies in a world that seems determined to take over all low and medium high amateur bands in their obnoxious spreading of their own brand of propaganda.

All amateurs should be keenly interested in what ARRL does and what it accomplishes with this $100K fund. This reporter has seen little of the results except the Stanford and Waters reports. The latter, at least, was worth it! That, plus some HQ staff junkets to foreign lands is what has been seen in QST.

ARRL can afford to spend almost its entire resources in order to effect suitable safeguards that will help preserve and retain our useage of all bands. $100K, if properly expended, can do a great deal of good for AR!

ARRL Membership–Item 42 orders that a postpaid insert inviting membership be included in selected ARRL publications and in QST, once a year.

The necessity for such a Board directive escapes this reporter. HQ should have been doing this for years. Such a motion, or the need for it, raises the question–does ARRL HQ really want ARRL to have more members? More members–more work–remember? How about an ARRL membership contest–with prizes? This idea (Item 42) should bring results–if it is followed up.

QST–A motion to include a propagation column in QST was lost when it was tabled (Item 66) by a vote of 12-4.

Some will argue that this information appears in other publications. True, and some have wide circulation, but what about those die-hards who read only QST–and need this information? ARRL should serve its membership regardless of other publications.

Item 68 requests a study to secure more rapid delivery of QST in 6-land, KH6, KL7 and all parts of US and Canada and requests that the results of this study (by the General Manager) be made not later than the next Board meeting.

In by-gone days one could tell the date by the arrival of QST. This reporter believes that the poor delivery is not the fault of the QST and HQ staff, and offers a thought that perhaps the postal employees are delaying QST by reading them before delivery! Could be potential amateurs? Maybe! If they were ARRL members they would get their own copy and thus perhaps speed up ours!

ARRL-FCC Matters–This category is lengthy and somewhat confusing. An attempt will be made to simplify the various proposals and their fate at the hands of the Board.

Item 13 requests that ARRL petition FCC to permit Conditionals or higher in the KL7, KH6, KP4 and USA insular possessions to use phone on 21.2 to 21.25 mhz. Also, that ARRL consult with IARU regarding a future petition to FCC to permit phone on these same frequencies by Extras. An amendment withdrew the IARU bit, but the amended motion was defeated. No vote count was given.

Item 14 would petition FCC to permit Techs to use 29.0-29.7 mhz. This was amended to read 29.5-29.7. Vote–14-1 with the Canadian director abstaining as is done in matters pertaining to FCC.

The Planning Committee was instructed (Item 19) to consider the feasibility of petitioning FCC to–

Expand 75-fone to 3750-4000.
Move 80-Novice to 3650-3700.
Expand 40-fone to 7150-7300.
Move 40-Novice to 7100-7150.
Expand 20-fone to 14175-14350.
Move 15-Novice to 21100-21200.

This Item 19 also instructed that a report be made by the next Annual Board Meeting. This motion was amended to establish liaison with IARU to evaluate international aspects of these possible changes and to report by the next Annual Board Meeting. The amended motion was passed. A large follow-up tag, please, Miss Blue!

IF Item 37 is followed through and IF FCC acts favorably, devotees of the art of EME, MS and other valued VHF/UHF pursuits will be granted higher power.

Note the IFs in that statement. High power would tremendously aid important work being done by pioneers in the most valuable facet of amateur radio yet encountered and which may well become our only area of activity in the near future.

Item 53 requests FCC to make 144-148 available for Technicians instead of 145-147. ARRL will so petition FCC.

After all somebody has to use those highly valuable 4 megs! It is assumed the Techs would have the same fone-cw regs as others.

If FCC agrees with the motion made in Item 55, potential Extras will only have to wait one year to take the Extra exam instead of the current two years.

Note the IF. This is a good idea, and let's hope FCC likes it. Novices and Technicians will benefit if the intent of Item 55 is OK'ed by FCC and permission is granted for Techs to obtain a Novice license without surrendering their present license and waiting one year.

An excellent proposal will be made to FCC that a typewriter (provided by the amateur) be permitted in copying code exams. Item 73 (always a good number) covers this but its originator, the well-known contester and triple-A CW op, W4KFC, overlooked petitioning FCC to permit headphones over the ears of aspiring examinees! Any trembling gun-shy neophyte will welcome a mill and maybe, someday, headphones again.

Item 74 (which was passed) requests FCC to assign 1x3 (preferred) calls to Extras who request and pay the fee, such calls to be assigned on a random basis.

If this idea gets FCC's nod, some Extras may get desirable calls. Oh, for the old days of call-swapping and initials in your call and all that sort of thing, sans computers!

MM boys will be pleased if ARRL's support (Item 95) leads to FCC's approval of MM on 7 to 7.1 mhz.

AR will benefit if MM is so allowed, as MM-working is both exciting and valuable for contactees.

RTTY addicts will probably rejoice if FCC grants RTTY operation on 28-28.5 mhz (Item 96)

but this is not likely to be favored by non-RTTY ten-meter ops!

This same Item 96 asks FCC to move "CW only" operation from 147.9-148 to 144-144.1. It should have been there long ago. ARRL endorsed FCC's docket 18508 covering this item.

Although belatedly, immigrants to our shores will be permitted ham licenses (after filing their first papers) if K7UGA's bill S-1466 and SJ Res 27 become law. ARRL approves this (Item 97) bill as should all other American amateurs. Reciprocity works wonders!

ARRL HQ Station W1AW–HQ was ordered by Item 15 to establish beacon stations on one or more VHF bands, as soon as practical, to operate at regular hours and on a published schedule.

This recognition by the Board of the importance of VHF in the ARRL program, although belated, will be appreciated by all amateurs who realize the necessity for heavy HQ participation in VHF research if ARRL is to keep up with the state of the art and advance VHF/UHF. This reporter firmly requests that ARRL put an EME station on the air, without delay! ARRL HQ should lead the way–not follow the crowd!

Item 21 would have moved ARRL's W1AW code practice and bulletin transmissions out of the Extra Class portions of the bands, but the motion was defeated.

W1AW should be operated on the border (in the opinion of this reporter and others) between the high and lower class segments, where practical. ARRL's argument that W1AW is not a frequency standard station may be true, but perhaps the Comm. Dept. should investigate 1969-type high-stability transmission possibilities. Few stations are equipped with 25-khz markers (even if they have a calibrator) and W1AW could help them know where these borders lie. ARRL could not be held responsible for a legal WWV-type frequency accuracy, but being near the border (a no-mans land for the holders of the lower classes of license) could be a boon for all.

Item 49 (debated and finally adopted–vote 14-2) calls for W1AW to make a six months trial run of a repeat of the 0230 GMT scheduled code practice at 1300 or so, five days a week.

Why would any director (two did) vote against such an idea? Maybe these two did not wish to rise at 1300 to improve their code.

The ARRL Board has consistently persisted in using an irritating practice of "referral to a committee for study," or other delaying tactics when faced with a sticky problem with which they did not wish to cope or make a firm decision.

Item 67 is just such a delaying tactic as it authorizes a committee to work with the OSCAR group and Foothills College in California to investigate the establishment of a joint ARRL/OSCAR station at OSCAR HQ.

Is this to be the "west coast official ARRL station" mentioned in League Lines, June, 1969 QST or is this to be the $1500 ARRL Space Station?

The Electronics group (plus able volunteers from industry) demonstrated their many capabilities and abilities in the well-executed OSCAR programs to which ARRL gave lip service, some QST space, and the ARRL Technical Merit Award.

This reporter believes that a joint OSCAR/ARRL station would be like the infamous "horse-rabbit" meatloaf, made of equal parts, one horse and one rabbit. Name the horse OSCAR.

The idea of a west coast location for either a W1AW-type operation or a Space station is meritorious and should implemented without further delay! Yes, Virginia, there IS a west coast!

If this is the HQ's answer to the 1967 (Item 24) directive allotting $1500 for an ARRL Space Station, then why wait any longer?

The director of the Pacific Division (in which OSCAR HQ is located) is to be commended for his fortitude and success in getting a "study" ordered. But, why a study on a west coast ARRL station? There has been a dire need for such a facility for many years and it will be welcomed by all who live west of the Hudson!

The Board recognized AMSAT (see June QST) and OSCAR by (Item 99) appointing liaison directors to these timely and vital programs.

However, by their omission of NASTAR they indicated either their indifference to the placing of a ham repeater on the Moon, or their ignorance of NASTAR, or both.

$1500 for an ARRL Space Station? Many VHFers have antennas that cost that much. ARRL's stated worth (Dec. 31, 1968) was $1,244,288.45! Is ARRL really interested in VHF or not?

ARRL and VHF Repeaters–the modus operandi of the Board can not be more clearly demonstrated than in the progression of a good idea to a weak one–as shown in Items 20, 38, 51 and 89.

Item 20 (tabled) comprehensive reporting of and an interest in VHF repeater operation by HQ personnel and in QST space. Item 20 also called for a section of the ARRL H-Book to cover VHF repeaters and their operations. This motion was well organized, vitally needed by those who get their kicks form this newest facet of ham radio, a phase that is rapidly growing in popularity and usefulness.

Item 38 (tabled by a vote of ARRL's President, after a tie vote by the directors) called for a separate VHF REPEATER handbook to be written and published by ARRL.

In Item 51 the director who made the proposal in Item 20 (apparently in a desperate effort to salvage something from his good idea) amended his original motion, albeit emasculated, to request QST to carry news of VHF repeater activities in a principle subsection of The World above 50 MC. This amended motion was then passed.

The same director then proposed (Item 89) that ARRL include a section on VHF repeaters in the 1970 H-Bk. This motion passed.

Note that Item 89 calls only for a section in the '70 H-Bk.

Your attention is called to Items 20-38-51 and 89 as a study in Board procedure, when faced with HQ opposition and Board indifference! This study should be entitled–"how to have a good idea ruined without really trying!" The reporter is sure that ardent VHF repeater fans will have less than a huzzah for the Board on this matter.

Item 61 authorizes the General Counsel to file comment and to petition FCC to impliment the report of the VHF Advisory committee with consideration given the status of various related rule-making procedures now pending with FCC.

ARRL-RTTY Matters–ARRL approved (Item 17) FCC's Rm 132 (pending) permitting RTTY operation at 60, 75 and 100 wpm. Good thinking!

Director Affairs–Several motions were made regarding directors, their duties and other matters.

Item 11 called for procedure of impeachment of any office holder elected pursuant to the Articles of Assoc., the By-laws and the responsibilities of his office. This motion passed. Perhaps we may now have a method of ridding ARRL offices of incompetents.

At last (Item 58) ARRL directors (not vice directors) are authorized to attend ARRL National conventions with expenses incurred chargeable to authorized division allotments.

It might be noted that the 1969 ARRL National Convention was scheduled for Iowa, the home state of ARRL's president. Any connection purely coincidental.

Why has it taken until '69 to get such a worthwhile measure passed? Not many directors have the wherewithal to travel on their own expense and few can arrange "business trips" to permit their attendance at ARRL's own national event. This motion is worthy and this reporter trusts that all directors will take full advantage of it.

Item 36 (which passed) is of extreme importance! It is also highly significant of what may be a new progressive spirit in the Board.

A Special ARRL Board meeting is called for Nov. 1, 1969 to consider or act upon the following–

1. Actions pending before FCC.
2. Reports and studies of HQ staff.
3. Amateur band occupancy.
4. Committee recommendations.
5. Establishment of an ARRL Foundation.
6. Recommendations of Counsel regarding amendments to provide for two meetings of the Board each year.

This item also states that any other matters to be placed on the agenda may be added up to and including Oct. 22, upon concurrence of at least nine directors.

Note that a majority must concur even to get an item on the agenda. However, the agenda is potentially loaded!

Item 36 also urged directors to arrive at the site of the meeting as far in advance as possible and reasonable for committee and informal conferences.

This is SOP, allowing several days for informal (non-reported in QST) conferences at which most items are fairly well firmed-up and prepared for the "formal" reportable meeting. This May meeting was not marred by "committee of the whole" tactics. Several recesses were called for the purpose of discussion, off the record, and other necessary rest periods.

A second meeting each year, if made official and acted upon yearly (after '69), will be one of the most lasting and beneficial acts of the May meeting. The ARRL has long suffered from a communications gap with a year between meetings. This has often resulted in permitting the Exec. Comm. (which meets frequently) to act without referral to the full Board or to handle matters which should be Board-controlled.

A single yearly meeting for a megabuck corporation, is less than justifiable. This demand for a second meeting is commended. It is truly a step forward in directorship. If directors meeting in November will study the minutes of the May meeting as well as those of recent years and follow-thru on some of the unfinished business (tabled or otherwise) something of value may be achieved.

The agenda of the November meeting contains controversial items and the meeting should be most intriguing!

Item 76 lists budgets for administrative expenses of directors for '69. These amounts are set by the individual director who may request any amount deemed necessary to spend in the interests of ARRL in his division. These amounts range from $1000 to $3200.

With the high cost of travel and printing, it appears that these figures are (for the most part) puny. There would be no objection if any director raised his expense figures although when this reporter was a director there was some effort on the part of many directors to see just how cheap he could be in his directorship, rather than see what was needed to really do a job of representation and request sufficient money to do the job.

Many directors must spend money out of their own pockets to fulfill their responsibilities and this does not seem proper when the ARRL gross income is large (1968–$1,498,574.62) and the need for better and more extensive communication between director and member is so prevalent. With larger budget authority each director could more effectively represent ARRL in the field.

Item 34 provides vice directors with advance copies of QST each month. Now, that is a magnanimous gesture on the part of the directors. At least vice directors get that much out of their almost non-existent duties. ARRL officers receive no salary.

One of the motions that can usually be counted upon at each Board meeting is contained in Item 92. This motion called for authorization to permit vice directors to attend (at League expense) one Board meeting during a two-year term of office. This long-needed authorization was defeated by a vote of 9 no–7 yes!

The thinking of those nine directors must be fuzzy. Why would not they welcome the presence of vice directors at the Board meeting so they could see what goes on, first hand, at these meetings. Many cannot afford to do this. Vice directors can only monitor the meetings anyway, and have little or no voice.

Vice directors, could if allowed and encouraged to do so, become a vital part of the activities of ARRL policy-making. But NO! Not only are they excluded from such opportunities they are forced to either pay their own way or obtain funds elsewhere to attend a convention or meeting. It is time that vice directors were recognized and brought into the ARRL political picture and activity to the fullest extent. Their talents are badly needed in the field!

Ironical as it may appear the ill-fated motion in Item 92 was followed by a unanimous vote of appreciation by the Board for the several vice directors present–ad nauseum! Such a motion seems rather puerile and in the case of nine directors, penurious!

Electioneering–Items 10 and 70 provide another example of Board stalling by referral to a committee of a sticky problem.

Item 10 calls for procedure wherein candidates (for director or vice director) would furnish HQ written information concerning his qualifications (not more than 200 words) and a list of his amateur radio affiliations. This material was not to contain any derogatory (by innuendo or directly) statements regarding any opponent for the office. This material to be prepared with a photo (if supplied) in a standard size sheet for each candidate so furnishing the information, and published, with no HQ editing, then enclosed with the ballot sent each potential voter. The same item provided that no lists of names and addresses or addressed envelopes be supplied to any candidate or his committee or to anyone for electioneering purposes. This motion was tabled by a unanimous vote.

Another stall was made when in Item 70, the same director presented an almost similar motion, albeit shortened, with the same motive. Another amendment assigned the matter to the Planning Committee for study. This amendment passed 10-5. The whole idea was then demoted to a "study of election procedures by the Committee" by another unanimous vote.

A uniform electioneering literature release, with the ballot, would be beneficial and would save much expense on the part of electioneering groups, provided, of course that HQ did not censor or edit such material submitted and that no difficulties arose as to what constituted "derogatory remarks," etc. All candidates would therefore have the same opportunity for exposure, at less expense, than with the present method which is unfair in that it gives a break to any candidate able to raise sufficient funds to widely advertise and also deprives candidates not so fortunate, who may be just as qualified for the office. Holding any ARRL office should not be contingent upon how much money a candidate or his supporters can raise.

This reporter hopefully looks for this reform at the earliest opportunity. And, that the intent of the original motion be preserved, in toto!

Item 46 is a somewhat confused attempt to secure redress through a committee of tellers for unfair, unethical or otherwise undesireable action by, or on behalf of an opposing candidate. Such complaint to be made in writing. A move to table was lost as there was no second. After more discussion, another tabling motion passed, 12-4.

The thinking behind this motion may be well founded but the intricities of handling such a complaint would challenge the mind of a Solomon. Regardless of that fact, tabling such a motion solves nothing and is an indecisive way of handling a hot potato but indicative of the lack of direct action displayed by the Board on such occasions. Sort of reminds one of the Congress! Sweep it under the rug, boys, and forget it!

Communications Department–In Item 59, the Board created a five-band WAS award to be initiated by the Comm. Dept. and effective after its availability.

This is an excellent award idea and should create a lot of interest in domestic operation but it is hardly a matter for deliberation by the directors of a megabuck corporation.

Why did not the Comm. Dept. just up and create this miracle and put it into use? Perhaps it was not their idea at all, and it does mean more work for the Comm. Dept.!

Those seeking credit for their personal net accomplishments will be pleased to learn that ARRL's Comm. Dept. will now recognize (a) net check-ins; (b) net control duties; (c) net liaison duties; (d) Emergency Corps participation; (e) phone patch operation. Points are to be established and reported in QST by SCMs. This motion was unanimously accepted in Item 65.

This reporter is fully aware of the importance of certain types of net operation and the training

value contained in some nets and does not belittle such activity. It does appear that QST space could be better occupied with articles on net operation and net concepts of general information to all, thus stimulating more interest in and understanding of the motives and practices of the better class of nets.

The point standings could be better handled in the Comm. Dept. voluminous bulletins sent to those interested rather than take away QST space from technical and other valuable material. Only a few QST readers have interest in traffic matters.

What a comedown for the Comm. Dept. to have to recognize phone patching and to have to issue points for it. Wow!

Stand by for a cut in readable QST space and an appropriation for computer rental!

The Board, after deliberation, established the ICAO phonetic alphabet (Item 63) as approved

Now to get the lads to use it—or any other standard phonetics. It is unlikely that ARRL approval is going to reduce or change the silly practice followed by so many with their inane and confusing self-established phonetics.

Item 82 will change the rules to require that candidates for SCM must have been a Full Member of ARRL and, to have held a General, Conditional or higher license, for two years.

This is a good move designed to insure better qualified persons in this important, unpaid and difficult task of being an SCM.

Item 83 places the determination of the standards of qualifications for an OO to be the responsibility of the Comm. Dept. Manager. OO—Official Observer—a volunteer Grand Island-type, with no authority or back-up to cause operators to "fly right." SCM—Section Communications Manager—a volunteer unpaid local representative of ARRL at state or geographical level. Reports in QST and handles traffic matters for his area.

Contestees will delight in Item 33 and all others (a majority) will climb the nearest wall! This item proposes a Comm. Dept. party once a year in which members are invited to work the League's official family of officers or appointees.

There used to be a similar type contest called LO Nite (League Officers Night) and it is surmised that this new bit of QRM-making "togetherness" may be in addition to LO Nite.

This reporter wonders if certain League officials will answer pointed questions during these QSOs? Let's find out!

SCMS and the Board—Item 18 instructs the General Manager to furnish each SCM (at his request and at ARRL expense) a set of training and operating manuals. The SCMs are perhaps the hardest working members of the LO, and they must be a real hardy breed!

ARRL and its Affiliated Clubs—Item 16 (which failed to pass due to no second) would have furnished a free sub to QST to any affiliated club who could produce ten members of ARRL who would sign such a request. The loss of this motion, due to failure of a second, is lamentable and sure is poor PR!

ARRL and the DXCC—The Board again delved into petty non-Board deliberations when (in Item 47-passed) it permits DXCC members to submit QSLs in increments of 10 after 250 countries have been credited. A worthy idea—but hardly a matter for Board consideration.

Item 56 attempted to secure a unified countries

list. After several amendments and much deliberation the following was adopted—"that the President and General Manager study the feasibility of implimenting preparation of a countries list jointly prepared by IARU societies."

This will solve nothing! Many of the important countries lists (and awards) are made by groups, organizations or publications who are not IARU members. The original motion was well-organized and important. Read it in QST and see for yourself. It should have been passed without debate. Now sometime we may have an IARU list, which will be dominated by ARRL's DX clique, and it will be ineffectual!

In the '50s this reporter advocated and fought for a DX committee with representatives of leading ham organizations, DX clubs and publications. This idea was defeated. Result—utter confusion in the DX ranks as to what, where, when is a country. By the beard of TOM—this IS a Rotten Mess!

ARRL Foundation—Item 28 instructs the General Manager and Counsel to promulgate the establishment of the ARRL Foundation, as a separate non-profit corporation. Objectives and purposes to provide ways and means for permanently establishing authority to utilize special funds and property of the Foundation and income therefrom under restrictions as might be imposed. (The motion is long and wordy and does not coinside with the version given in League Lines June QST). The Foundation would be managed by a Board consisting of the ARRL President, Treasurer and Secretary plus other director-elected members.

The basic idea appears to be a means whereby ARRL can receive funds (gifts, bequests, etc.) and expend them as a separate corporation from ARRL Inc. The outcome of this excellent idea will be forthcoming in November.

It is hoped that the Foundation will not be as miserly as is the official body of the parent corporation when it comes to advancing the state of the art of amateur radio and stimulation thereof!

ARRL and Assistance to Foreign Amateurs—Item 82 voted unanimously that ARRL continue its program of assistance, etc.

There is no quarrel with this motion except that ubiquitous word continue. Study of past ARRL affairs reveals little that has been done in this line and to continue along the present path of "assistance" does not seem to be of much value to anyone. ARRL could and should do a great deal in this line—but like many, this reporter believes that charity begins at home. Perhaps a communications gap exists between HQ and the reader-membership or perhaps it is another example of the familar phrase—credibility gap!

Conspicuous by its absence was reference to the ARRL Space Station ordered installed under Item 24, 1967 minutes, unless Item 67 can be so construed as to that station to be located at OSCAR HQ. No mention could be found in the '68 minutes of the Space Station.

Another matter not mentioned in '69 minutes was the ARRL out-going DX QSL bureau as discussed in Item 37 of the '67 minutes. A study and report was ordered (Item 17–'68) and was given to the Executive Committee Jan. 1, 1969, meeting 325. The committee unanimously voted against the establishment of such a bureau concluding "that it would be in the best interests of amateur radio not to expand the existing system."

The existing system is that of HQ receiving incoming QSLs and sending them to unpaid volunteer bureaus who mail cards to those having envelopes on file in the bureau.

This incoming system is excellent due to the hard-working and tireless group of volunteers but ARRL (the largest and most wealthy) amateur radio organization in the free world should long ago have established an outgoing DX QSL system.

The Executive Committee decision appears to be another example of abrogation of responsibilities by the Board who passed the buck to the Exec. Comm. whose record in the past has been toward the reactionary side.

There are at least two out-going QSL bureaus doing business at this time. Perhaps DXers are better off dealing with "private enterprise" than with an agency, especially if it does not want to do the job.

In addition to the above items the Board considered and acted upon various other matters in one way or another. Most did not seem of sufficient import to be reported here.

A sincere effort was made to preserve the intent and meaning of each motion discussed. Although some were paraphrased for brevity, in no case was any idea or motive deliberately distorted or taken out of context.

Deliberations and decisions of the ARRL Board of Directors (as well as those of the Executive Committee) affect ALL amateurs and AR. You are urged to carefully study the minutes in July QST and, with this commentary at hand, attempt to reach your own conclusions as to the results of this meeting.

A ball-park estimate of the items in the entire proceedings resulted in a tally of 38 that were beneficial, in one way or another, to AR, and there were 16 that were considered negative. You can make your own tally after digesting the minutes.

. . . W7ZC

A Cheap and Easy Power Supply

Earl Spence K4FQU
1413 Davis Drive
Fort Myers, FL 33901

Many of the transceivers on the market oday are packaged separately from the ower supplies. The easiest way out is, of ourse, to pay the $100 (or so) and buy the ower supply along with the transceiver.

But if you happen either to be obstinate r hold that $100 in a little more awe than eems to be average these days, you might vant to follow my lead and build your own ower supply.

First, let us examine what is needed in a ower supply capable of powering an SSB ransceiver of the NCX Class. Most similar igs utilize about the same voltages and urrents. We find that my rig required a final late voltage of about 700 vdc at 300 ma vhich is maximum current under load. A ias of 80 vdc negative at 6 ma, 280 vdc upply at 200 ma, and of course filaments, nake up the balance of the needed voltages. This is not a lot of power and can easily be urnished with a good husky TV transormer. The transformer is the most expenive portion of a power supply and, natually, the most important, so care should be aken in choosing it. Test the one you select o make certain it will deliver under proonged load without overheating. It is far asier to check before than after the supply s finished. Keep in mind that the transormer has to produce full voltages under PEP conditions so the full drain even at top oad is not extremely heavy. Therefore don't overlook a transformer just because it is not s big as a bread box.

My junk box produced a number of likely looking transformers, but none had just the right voltages. A little scrounging in a friend's junk box turned up one which did. It was center-tapped, produced about 750 volts across the winding and was large enough to gamble on its providing the needed current. It also had three filament windings which are used for the bias transformer and the filaments. The bias transformer is a cheap 6.3 volt filament transformer and is run backwards off the 5 volt winding of the power transformer to produce about 100 volts.

The output high voltage of the power transformer was a little over 700 volts using a solid state bridge rectifier and the center-tap was used for the low B+ supply. Although theoretically the center-tap should have produced about 350 volts, this one only ran 300 and dropped under load to 285 volts . . . just about on the nose.

Fig. 1 shows that the circuit is clean and straightforward and not of unusual or new design. It should be quite easy to understand, even to those of us with limited knowledge. Notice the bias supply in particular. This is an easy method of obtaining negative voltages and has been used in many similar circuits. The output of the reversed filament transformer is rectified by a single diode of the same type and ratings as those in the bridge network. Although I included a variable pot in this bias supply, it is not

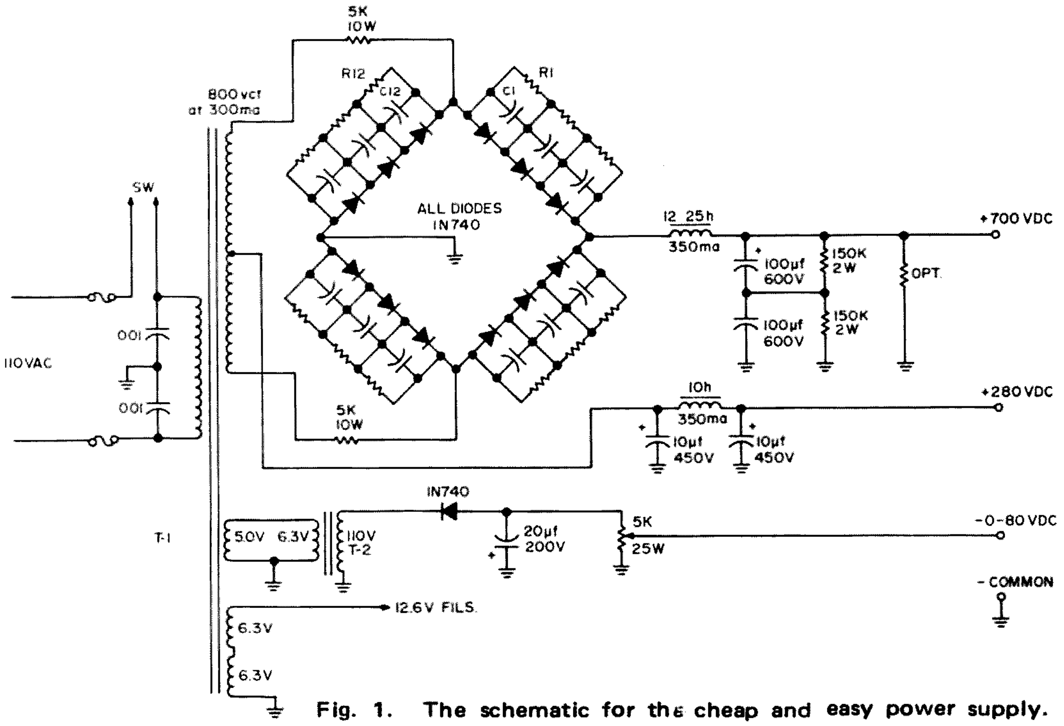

Fig. 1. The schematic for the cheap and easy power supply.

needed for the NCX-5 as it has a pot for this on the rear apron. Mine was included, since the supply is used on occasion as a bench supply. You may elect to do without it.

Physically the supply is small though quite heavy (about 35 pounds) due mostly to the transformer and the two chokes. It is built on a 2 x 8 x 10 inches aluminum chassis with the transformer and two chokes mounted on the top along with the bridge network. It has enough room to include the speaker if you wish. Control circuitry, filters and bias transformer are mounted under the chassis with lots of room for large fingers. All connectors are brought out one end of the chassis and include a nine pin Jones connector, an RCA phono plug for the speaker lead, the bias pot and the ac line. No switch is required in the ac line as this is done in the transceiver; however, I have one built in for bench use which is left in the on position when used with the rig (not shown on the schematic). The ac line should be fused in each leg per standard safety measures.

The heart of the unit is the diode bridge network and a few words are in order about the subject. All diodes are the top hat variety and are readily available in most local supply houses at about 50 cents each. They are rated at 400 volts PIV and 750 mil capacity. This is a full wave bridge using three diodes in each leg or twelve in all. Each diode is protected by a resistor and capacitor in parallel across it. Surge resistors are used ahead of the bridge in each leg; without them you might soon be replacing diodes.

Mount the bridge network on a small piece of Vector board about 2 x 4 inches. This board should be the type on which the lugs go through the board on both sides. Mount all the diodes on the top side of the board running around the board so that it is fed from the center on both sides. Ground and the dc will be from each end of the board. Mount the resistors and capacitors on the under side of the board making sure that they do not short across the board. Bore a hole in each corner of the board and mount on 1" stand-off insulators. Be certain that nothing shorts to ground or you will have smoke!

The rest of the supply is common sense and so nothing more will be said about it. Make a cover with Reynolds perforated aluminum and paint to match your rig. Take care so you can be proud to say that you built it. This circuit and supply is not offered as the perfect solution to your needs, however it will suffice with minor alteration for almost any modern 200 watt SSB transceiver.

I have been using this power supply for about a year now without a moment's trouble. It ran the NCX-5 for 24 solid hours

during last field day and was cold to the touch at all times. It just recently ran the SS contest and ran cold even after a brief exchange with W2NSD/1. The transceiver can be loaded to about 60 mils over maximum so it is evident that there is plenty of current. Plate voltage under full load runs a hair under 700 volts. On the air reports are good and it has no noticeable bogies.

Total investment for all parts that the junk box did not supply came to about $18. Included among these parts were all the diodes, chassis and a filter capacitor. It's a far cry from the $110 plus tax for a commercial supply.

. . . K4FQU

RENEWAL CODE

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Getting Your Extra Class License

Part IX – Modulation

73 STAFF

One factor which all forms of communications share is "modulation." While we use the word, in radio, to refer to a specific process involved in generating a signal for transmission, it's used elsewhere with much wider meanings – as for example in the phrase "he has a well-modulated voice."

Even if we limit ourselves to the meanings of "modulation" involved in radio, it's a most important subject. A major group of questions in the Extra Class license examination study list deals with various specifics of modulation – and that's our subject this time.

The FCC's study questions which we'll cover are:

1. What are sideband frequencies? During 100% sinusoidal amplitude modulation, what percentage of the average power is in the sidebands? How is the sideband power related to the percentage of modulation?

2. What do the modulation envelopes of amplitude-modulated waves with 75%, 100%, and greater than 100% modulation look like?

18. Define the deviation ratio in a frequency modulated signal.

19. What type of signal will be produced when the output of a reactance modulator is coupled to a Hartley oscillator and multiplied in frequency?

56. What is a grid-bias modulated amplifier? Should the source of fixed bias have a high or low internal resistance? Explain.

63. How are reactance tubes used?

As is our usual custom, we won't answer these six specific questions directly, Instead, we'll paraphrase them into four questions of much broader scope which will cover the details involved in the official questions.

For a starter, we'll attempt to find out "What is modulation?" After all, we can't very well examine the details of anything until we know what we're trying to examine. An adequate definition of modulation, also, may help to put the rest of our discussion into a proper framework.

Having defined "modulation," we can then ask "What can we do to a signal to modulate it?" This will sort out the various forms of modulation into appropriate groups and, along the way, will define the major classes of modulation types.

When we know *what* we want to do, the logical successor in our list of questions is *how*. That's our third one: "How can we modulate a signal?"

And finally, having seen how to produce modulated signals using any of the major classes of modulation which are in wide use by hams, we need to examine the characteristics of these modulated signals. Our last question this time will be "What are the characteristics of a modulated signal?"

We've got a lot of ground to cover to answer those four questions; we're on our way!

What Is Modulation? As we observed back at the beginning of this installment, "modulation" is a word with many meanings, and only a few of them are applicable to radio communications in general or to ham radio in particular.

For radio usage, the word has been defined many times in many ways – and then applied with some new meaning which has made the older definitions obsolete.

An example: In 1938, the Institute of Radio Engineers published an official definition of "modulation" as being "the process of producing a wave some characteristic of which varies as a function of the instantaneous value of another wave, called the modulating wave."

This definition was adequate until the rise of telemetry, in which the modulating signal is as likely to be a dc level as it is to be a "wave" (whatever a wave may be). When the modulating signal is a dc level, however, the 1939 definition must be interpreted rather liberally to be applied.

Neither does it adequately cover the concept that what we call CW is actually amplitude modulation (see last month's installment for a discussion of this idea) – and when RTTY is involved, it gets downright difficult to visualize the FSK signal as being the product of a "modulating wave"; the definition had to change.

Another definition of "modulation" is that given in the *Radiotron Designer's Handbook,* fourth edition, page 1401: "The process by which the amplitude, frequency, or phase of a carrier wave is modified in accordance with the characteristics of a signal."

This one, too, is a bit short in view of modern practice. No SSB or other suppressed-carrier signal could satisfy it, but no one would deny that a SSB signal is modulated. Neither could any type of pulse modulation qualify as modulation, under this definition.

Note that neither of these definitions cited as examples is completely *wrong*; the trouble is that they're merely incomplete – and being incomplete is an unforgivable sin in a definition.

What's needed is a definition broad enough to include not only the types of modulation used in communications today, but hopefully all future types of modulation as well. We've had to generate our own to get one that broad, but we feel that it accomplishes the goal and defines modulation in such terms that we can move on to more specific details.

Modulation, as we use the word in this installment at any rate, is the transmission of information by variation of some characteristic of a transmissible signal (which we will call the carrier) in such a manner that the original information (modulating signal) may be recovered from the result (modulated signal) by a definable process without prior knowledge of the original information.

This does not require that the carrier be transmitted as a part of the modulated signal; elimination of the carrier itself may be one of the variations used to accomplish modulation. Just so long as information is transmitted in a manner which permits its recovery, that's modulation.

Note that this definition is so broad that a conventional land-line telephone circuit or intercom qualifies as a "modulation" system. The sound waves which are the original information vary the current flow in the connecting wires; if we consider the at-rest current as "the carrier," then the change in current flow when sound strikes the microphone provides "modulation," and when the earphone or speaker changes this current flow back to sound waves, that's the "definable process" which demodulates the signal. It's hard to get much broader than that while remaining specific enought to be useful.

In practice, though, we don't deal very much with intercoms or land-lines. We're radio operators, and we deal primarily in radio signals. Our "carrier" signals, then, will most often be radio waves.

Our definition of modulation permits us to vary any characteristic of our carrier in order to apply the modulation. Let's see what characteristics of a radio signal we can vary in order to modulate that signal.

What Can We Do To A Signal To Modulate It? We've agreed that our carrier signals are, most often, radio waves, and our definition of modulation permits us to vary any characteristic of the carrier to apply modulation just so long as we can recover the original information from the modulated signal by some definable process.

So the first step in deciding what characteristics of a radio signal we can vary to apply modulation is to decide just what

characteristics a carrier has in the first place.

A conventional *rf* carrier is a single-frequency radio wave; some attempts have been made to apply modulation to non-coherent or "noise" carriers, but that's far from general practice (and no one has publicly reported any success in these attempts so far as we have been able to learn). Such a single-frequency *rf* wave has three major characteristics: amplitude, or its strength relative to some scale of measurement; frequency, or its timing relative to itself; and phase, or its timing relative to an arbitrary starting time.

In addition to the three major characteristics of amplitude, frequency, and phase, there's an even more fundamental characteristic of its existence at all. If the wave does not have the characteristic of "existence," it has no other characteristics at all. This might appear to be a merely philosophical point – and at this level of examination it is. But if we accept "existence" as a characteristic, we can then extend this idea to accept a "pattern of existence" as a special form of the "existence" characteristic; and this opens the door to the exotic forms of pulse modulation which convey information, not by the frequency or amplitude of the carrier involved, but by the patterns in which the carrier either exists or fails to exist.

We won't labor this point very much, because pulse modulation is illegal on the most popular amateur bands, and we have more than enough to attempt to cover without getting into pulse work too deeply. We must, however, note it in passing in order to be complete.

The three major characteristics which are varied in the most popular types of modulation are illustrated in Fig. 1.

When we vary any one of these characteristics to modulate our carrier, the resulting signal is identified according to the characteristic which we vary. If we vary the amplitude, we produce amplitude modulation or AM. Both SSB and DSB are special cases of AM, in which amplitude is varied but in addition the carrier itself (and in SSB, one sideband as well) is suppressed from the final modulated signal. If we vary the frequency, we have frequency modulation or FM. And if we vary the phase, we have phase modulation or PM.

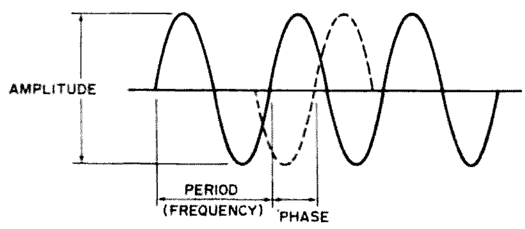

Fig. 1. The three characteristics of an ac sine-wave signal which may be varied to produce modulation are shown here. Amplitude refers to the peak-to-peak strength of the signal and may be measured in either volts or as current, so long as all references are consistent. Period is the time between two points of similarity in the waveform, such as the two zero-crossings shown; frequency is the reciprocal of period and is simply the number of cycles per unit of time. Phase is the timing between the signal itself and some arbitrary reference of identical period or frequency.

Fig. 2 shows a theoretical circuit which can be used to illustrate the differences between AM, FM, and PM. This circuit consists of an ac alternator driven by a dc motor, together with separate controls for the power applied to the dc motor and to the alternator's field coils (the power level in the field coil of an alternator or a generator controls the power level produced by the device).

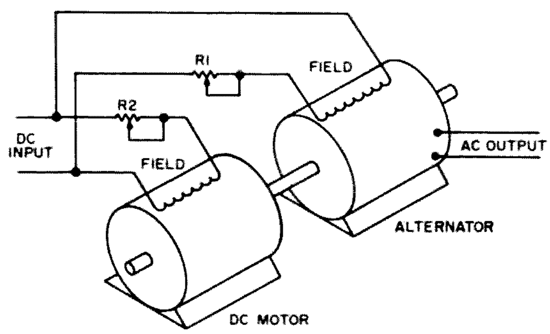

Fig. 2. This motor-alternator circuit illustrates the differences between the major types of moduation; it wouldn't work in practice because of the inertia of the moving parts, but it gives an idea of the principles involved.

Before we use this circuit to illustrate the three major types of modulation, let's brush up rapidly on some of the most basic facts of ac power generation by means of alternators. After all, it's not one of the things we usually concentrate upon as hams.

The major difference between an alternator and a generator is that an alternator

produces ac while a generator puts out dc. This difference is accomplished by the absence of either a commutator or brushes in an alternator. Instead, the output is taken off directly through slip rings. (In practice, the "field" of an alternator is usually the rotating part, while the "armature" is stationary; this is done because a small amount of field power suffices to permit a large amount of armature power to be generated, and the designers want to minimize the amount of current which must pass through the slip rings.)

The output power level, as we mentioned a few paragraphs back, is controlled by the amount of power applied to the field winding of either an alternator or a generator.

The output frequency of a generator is always dc, but · the ac produced by an alternator must have some frequency. The alternator's output is virtually always pure sine-wave in form, and the frequency is determined by the speed of rotation of the alternator's shaft. The faster the rotation, the higher the frequency produced.

Now let's look at the arrangement shown in Fig. 2, and imagine that the whole rotating system is so light and has so little inertia that we can change its speed of rotation almost instantly. For a start, though, let's adjust both R1 and R2 to their midpoints and take a look at the ac output. With both R1 and R2 steady, the power level and the frequency of the output will remain constant, and the signal will look like that shown in Fig. 3.

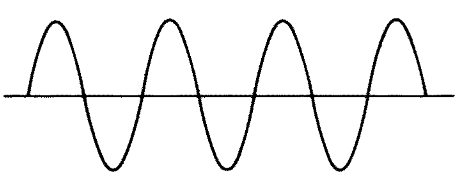

Fig. 3. If both power controls in the circuit of Fig. 2 are left in mid-position, the alternator's output will be constant in both frequency and amplitude, and will in consequence be a sine-wave signal such as that shown here. This corresponds to an unmodualted carrier signal.

Now let's vary R1 from minimum to maximum and back regularly, thus varying the amount of power applied to the field coils of the alternator and in turn varying

the output power level, but leave R2 set at midpoint so that the signal is still of constant frequency.

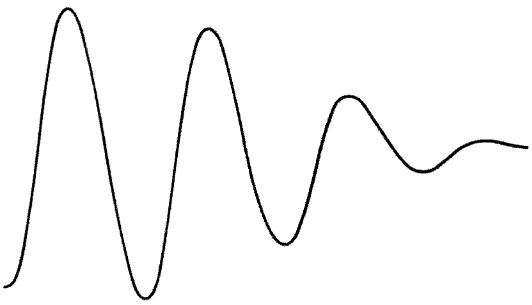

Fig. 4. If the speed control is left alone but the field power control is varied regularly from minimum to maximum and back again, the output of the alternator will be almost zero when field power is minimum and will increase as field power increases until it reaches a maximum, then fall back as field power is decreased. The resulting waveform looks like this, and corresponds to amplitude modulation of a constant-frequency carrier signal.

The result looks like Fig. 4. The period (which determines frequency) and the phase remain the same as in Fig. 3, but the amplitude varies from near zero to maximum and back down again as the field-coil power varies. This is amplitude modulation.

For the next illustration, we'll leave R1 set at midpoint so that output power level is constant, but vary R2 at the same rate as we did R1 before. Assuming that the dc driving motor can change speed instantly as we change the amount of power supplied to it,

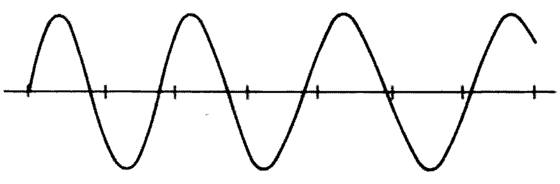

Fig. 5. When field power level is left constant, but the driving speed is varied from high to low and back, the alternator's output will be of constant amplitude but will vary in frequency. This is shown in this waveform; the tick marks on the time axis are the times at which the waveform of Fig. 3 crosses the axis, assuming that the leftmost zero-crossing occurs at the same time for boht waveforms. This corresponds to FM. All of these waveforms have been traced from an X-Y plot produced by an electronic computer, using a carrier frequency three times that of the modulating signal in order to clearly show the actions. Normal practice is to use a carrier of several hundred to several million times the frequency of the modulating signal.

and that the rotating system has so little inertia that it also can change speed instantly, our output signal in this case will resemble Fig. 5.

The amplitude is constant, but the period and the phase both vary as R2 is varied. The tick marks on the baseline in Fig. 5 show where the waveform of Fig. 3 crosses the zero axis. You can see that as the dc motor turns faster and frequency rises, the period of the output signal shortens, and as it turns

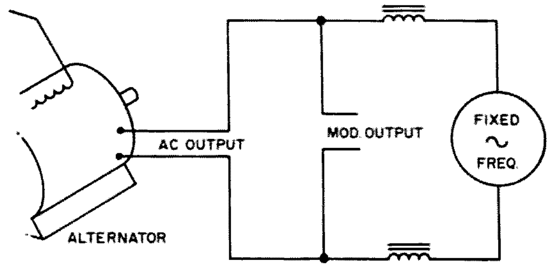

Fig. 6. If the circuit of Fig. 2 is connected to a constant-frequency generator as shown here, frequency of the output signal will be locked to that of the second generator. Varying speed of the alternator now cannot produce permanent change in frequency, but will produce change in phase of output signal while speed is changing. Result corresponds to PM, and has same waveform as FM shown in Fig. 5; differences between FM and PM are largely a matter of definitions.

slower, the period lengthens again. This is frequency modulation.

We could perform the same actions again as we did to produce Fig. 5, but connect the output to a fixed-frequency generator through large series inductances as shown in Fig. 6. When we do this, the frequency is locked to that of the fixed-frequency generator – but the phase will vary *while* the dc motor's speed is changing. This is phase modulation. We don't show a separate illustration of it, because for any single-frequency modulating signal, there is essentially no way to tell the difference between FM and PM at the output signal. The outputs of each are identical.

The functional difference between FM and PM lies in the fact that the amount of change in period or phase which occurs in the modulated signal is determined by different factors. When FM is employed, the amount of change is determined by both the strength of the modulating signal, and by its frequency. Lower-frequency modulating

signals give greater change for the same level than do higher-frequency signals. When PM is employed, the amount of change depends only upon the strength of the modulating signal.

There is no practical difference between the two types of modulation, since any filtering of the modulating signal ahead of the point at which modulation occurs can compensate for the functional difference between FM and PM, and permit an FM-type output signal to be produced by a PM modulator, or a PM output signal to be produced by an FM modulator. Most commercial FM broadcasting uses an output signal which is about halfway between true FM and true PM characteristics. Almost all commercial two-way FM equipment actually uses phase modulation, in order to permit crystal control of center frequency.

How Can We Modulate A Signal? Now that we have an idea of the basic characteristics and differences, if any, between the three major types of modulation – AM, FM, and PM – we need to know how we can modulate a signal with any of these types. The circuit of Fig. 2 is obviously not very practical for use at radio frequencies; we need something with a lot less inertia than a physical generator, and we must be able to control it with an audio-frequency speech signal.

Let's see just what we have to work with, and go from there. If we're going to modulate a radio signal, we have some type of *rf* carrier generated by an oscillator and brought up to the output power level we desire by a series of *rf* power amplifiers, and we have some sort of modulating signal which (except for TV) is an *af* signal.

To modulate that carrier, we must change its amplitude if we want AM, its frequency if we want FM, or its phase if we want PM. Whichever of these characteristics we change, the change must be controlled by the *af* modulating signal.

We can vary the amplitude of the signal in either of two basic ways. We can vary the amount of power supplied to one of the *rf* power amplifier stages, or we can vary the operating efficiency of one of those amplifiers. This can be done at any amplifier stage, but if modulation is applied to any

amplifier stage except the one finally feeding the antenna, then special care must be used to keep later amplifiers from distorting the modulated signal – that is, all amplifier stages following the modulated one must be linear.

We can vary the frequency of the signal by changing the operating conditions of the oscillator which originally generates the carrier.

Phase of the signal can be varied by change of operating conditions in any of the *rf* amplifier stages, or by special processing very similar to the "phasing" techniques used to produce SSB.

This all sounds simple enough, but for each of the three basic types of modulation an almost uncountable number of different ways of doing the job has been developed. To take AM as a partial example, we can apply the modulating signal to the plate, the screen, the control grid, or the cathode of the *rf* amplifier. If we apply it to the plate, we may connect it by means of a transformer, an autotransformer, or a choke. We may also combine any of these connections. And each of these variations of AM has its own name, and its own set of rules for achieving the desired results.

Before we explore any of the more specific details of the different techniques of achieving AM, let's look at some points which all of them share in common.

To do so, we'll take two sine-wave signals; their waveforms are shown on the top two lines of Fig. 7. We're using a 3-to-1 frequency ratio for these signals to make the illustrations easier to draw; in practice, the higher-frequency signal normally is several thousand to several million times the frequency of the lower.

If we apply either of these signals by itself to the input of an amplifier, we will get approximately the same waveform at the amplifier's output.

If we apply both at the same time to the input of an amplifier which is reasonably free of distortion, the output will look something like the waveform shown on the third line. The higher-frequency signal "rides upon" the lower, but except for that there's no interaction between the two.

But if the lower-frequency signal is

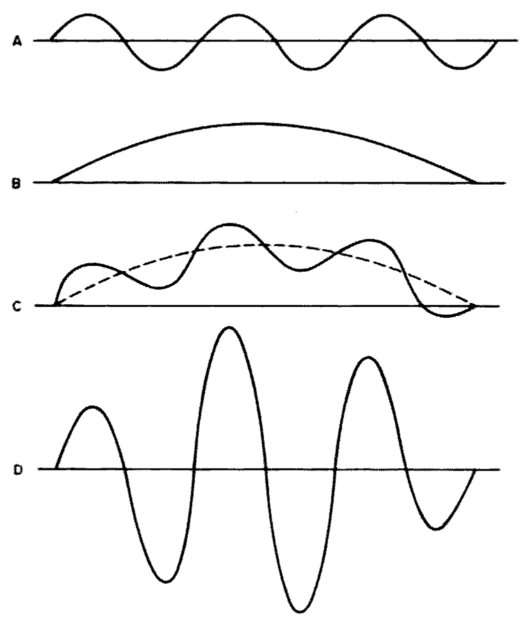

Fig. 7. These waveforms illustrate modulator action. Top line (A) is carrier signal and below that (B) is the positive half-cycle of the modulating signal. If both are applied to a linear amplifier, output waveform will be that shown at C; carrier swings about the lower-frequency waveform (dotted) rather than around the zero axis. Modulator's action is different (D); both signals swing around zero axis, but amplitude of carrier is controlled by amplitude of modulating signal. Object of AM modulation circuits is to achieve waveform shown at D.

applied to the amplifier in any manner which causes the gain of the amplifier to change as a function of that signal, and the higher-frequency one is applied to the input, then the output signal will resemble the waveform shown on the bottom line.

As you can see one of the major differences between the lower two waveforms lies in the "zero reference" of the high-frequency signal. In the bottom waveform, both the low and the high frequency signals are symmetrical about the actual zero line, but in the next-to-bottom waveform, the "zero reference" of the high-frequency signal actually is the waveform of the low-frequency one, shown by the dotted line.

A linear amplifier works to produce the effect shown on the next-to-bottom waveform; a modulator produces the bottom waveform.

Note that the requirement for producing the modulator-output waveform was that the lower-frequency signal – which represents the modulating signal – had to cause

the gain of the amplifier to change, while the higher-frequency signal – the carrier – was fed through from input to output in a normal manner.

One of the simplest ways to change the gain of any amplifier is to change its grid bias. This means that we should be able to feed the carrier to the amplifier grid as an input, and the modulating signal to the grid at the same time to vary the bias, and obtain modulating action. And, as a matter of fact, we can.

Grid-bias modulation, as such a technique for producing AM is called, has a number of characteristics which make it preferable to any other for some types of signals, as well as other characteristics which make it unattractive for general use.

Among its advantageous features is the fact that comparatively little power is required in the modulating signal; all that's necessary is a voltage swing great enough to produce the desired change of bias. Another advantage is that this technique is capable of handling a wide frequency range in the modulating signal, since no transformers are necessary. This feature alone makes it almost the only way to apply a video-frequency modulating signal to a carrier, and grid-bias modulation is the standard technique in TV transmission.

The same advantage is put to use in many receiver designs; any time a receiver uses a conventional triode or pentode as its mixer stage, with "control-grid injection" of the local-oscillator signal, a grid-bias modulator is at work.

The disadvantages which make grid-bias modulation unattractive for general AM use include its requirement for critical control of operating conditons. The variation of bias introduced by the modulating signal must change the gain in a more or less linear manner in order to satisfy the modulation requirement that the original modulating signal be recoverable by a definable process. That is, if the positive peak of the modulating signal increases gain by say 20%, then the negative peaks of the same amplitude must reduce gain by the same percentage. Otherwise the modulator's output will not be a true representation of the modulating signal, and any process for recovering the

information won't get back exactly the same signal we started with. In more conventional terms, the modulation will be distorted.

Adding to the problems of the grid-bias modulator is the fact that the modulating signal swings both positive and negative from zero, while the bias on a conventional amplifier must remain negative at all times in order for the control grid to retain control of the amplifier's action. We can take care of this by supplying a source of fixed bias, which offsets the zero reference of the modulating signal to some fixed negative voltage. Then the actual grid bias will swing from moderately negative to less negative when the modulating signal goes positive, and from moderately negative to more negative when the modulating signal takes a negative swing.

Since this fixed-bias source is electrically in series with the modulating signal, it must have low internal resistance. In fact, it must effectively be a dead short to ac signals at the lowest frequency present in the modulating signal. Grid-leak bias is not suitable; in practice, it's usually necessary to provide voltage regulation for the bias supply in order to keep the resistance low enough.

Other disadvantages to grid-bias modulation are that the modulated amplifier must be adjusted to produce only one-quarter of its maximum rated output in the absence of modulation; this is necessary because at the modulation peaks, the power output must be four times that at no-modulation levels. The modulated amplifier's grid imposes a varying load on the modulating-signal source, which can cause distortion of the modulating signal before it ever actually reaches the modulator, and the *rf* driver supplying the carrier to the modulator must be capable of supplying two to four times as much power as is normally used, again in order to supply the drive at the modulation peaks.

If a tetrode or pentode tube is used as the modulated amplifier, the modulating signal can be applied to its screen grid rather than to the control grid. Action is much the same as in grid-bias modulation, but adjustment is not so critical. Regulation of screen voltage is more customary than is that of grid bias – and in addition it's possible to achieve satisfactory screen modulation without regulating the voltages. The tolerances in screen modulation are great enough that many operators consider this the simplest and least critical type of grid modulation.

Advantages of screen modulation are circuit simplicity and the need for only a little modulating power.

Disadvantages are the need for more critical adjustment (as compared to high-level modulation which we'll examine a little later) and reduced output power capabilities.

All forms of grid modulation – grid-bias or control-grid, screen, or suppressor – are ways of varying the amplitude of the output signal by changing the operating efficiency of the modulated amplifier. Because of this, all of them must operate at below-normal efficiency in the absence of modulation, to leave room for modulation peaks when a modulating signal is applied. Most such modulating schemes operate at about 25% efficiency when there's no modulating signal, and produce their maximum rated output only during the relatively infrequent positive peaks of modulation.

It's possible to operate an amplifier at nearly its maximum rated output in the absence of modulating signal, and produce up to four times the maximum rated power during modulation peaks. We can do this simply because the modulation peaks are so infrequent that the amplifier components aren't damaged during the occasional overloads. To do this, though, we must stay far enough below maximum rating in the no-modulation or at-rest condition to permit *average* modulation levels to stay inside maximum ratings, and we must achieve our modulation by varying the supply power to the modulated stage rather than by varying its efficiency. Such a modulation scheme is known as high-level modulation, and it's the most popular form of AM in communications use.

High-level modulation is also called plate modulation, since the power variations occur in the plate circuit – but if the modulated state uses a tetrode, beam-power, or pentode tube the power to the screen grid must be varied right along with that to the plate in order to make things work.

This type of modulation requires that the

modulating signal be provided at rather hefty power levels; the modulating signal must supply half as much power as does the dc supply during at-rest periods. That is, a kilowatt amplifier that is to be plate modulated requires a modulator capable of supplying 500 watts of audio, and a transmitter operating with 100 watts input (dc) requires 50 watts of audio from the modulator.

The audio power, at audio frequency, is combined with the dc power and the result is applied to the modulated stage. One of the most popular techniques for doing this is known as "series" plate modulation and is shown in Fig. 8; the ac from the modulating

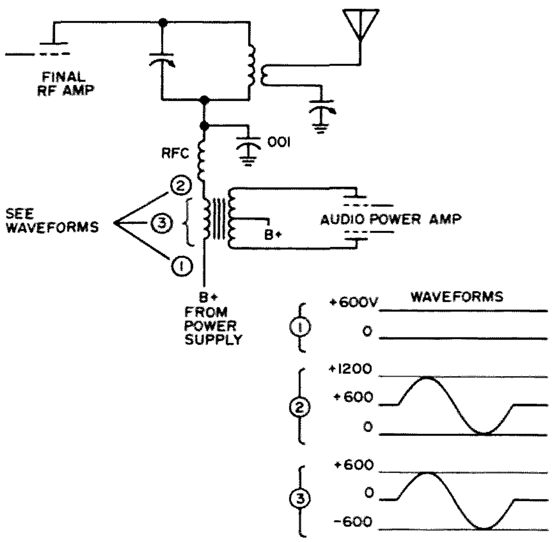

Fig. 8. Series plate modulator, version most popular among all AM modulation systems, is shown in this schematic. AC output from modulator either adds to or takes away from dc level of power supply, thus changing input power level to modulated rf stage.

signal is connected in series with the dc from the power supply. When no ac is present, the modulated stage receives the power supply's dc output with no modification. When a modulating signal swings the ac positive, the positive component of the ac signal is added to the dc from the power supply, and the modulated stage gets more power input than the power supply furnishes. When the modulating signal swings negative, though, it bucks out some of the dc from the power supply and the modulated stage gets only what's left. This reduces the power input, and so cuts down the power output.

For such a scheme to work, the modulated stage's output power level must be determined directly by its dc power input level; the amount of input signal fed into its grid circuit must not be able to affect power output. As it happens, a Class C amplifier that is driven slightly harder than necessary to saturate it fulfills this requirement. This fact makes high-level series plate modulation exceptionally simple to adjust.

It isn't necessary to connect the modulating signal in series with the dc power input as shown in Fig. 8. There's another way of doing it that gets by with a little less in the way of components, but is somewhat restricted in other areas.

This alternate way is actually an older technique. Instead of connecting the modulating ac and the power supply's dc in series, we can connect them in parallel. We must place a choke in series with the dc power supply so that it won't short the ac signal to ground. The result looks like Fig. 9, and the technique is known as "Heising" modulation.

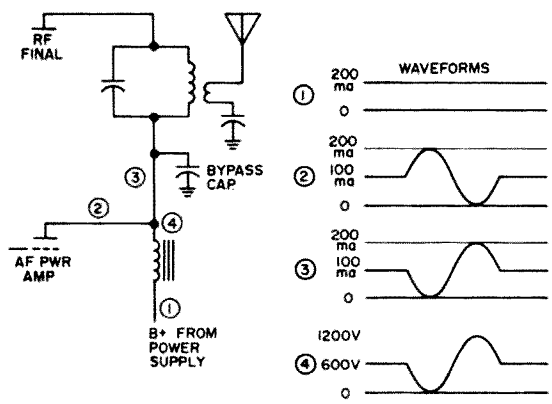

Fig. 9. Parallel connection of modulator and modulated stage is also possible. The circuit is known as "Heising" modulation and has many variants. It is especially popular for low-power equipment since it avoids need for bulky modulation transformers and is capable of excellent modulation quality. Disadvantage is that modualtor must be able to dissipate power equal to that supplied to rf stage.

Heising modulation can be looked at in either of two ways. We'll try both: To compare it to the picture of series plate modulation which we've just presented, in the absence of modulating signal the modulated stage gets full dc power from the power supply. When the modulating signal goes positive, it adds to the dc power and the series choke prevents it from affecting things on the supply side of the choke, but the modulated stage gets more dc than before. Similarly, when the modulating signal goes negative it subtracts from the power level on the modulated-stage side of the choke, and the choke prevents the supply from making the level up. Thus the effect on the modulated stage is the same as with series modulation.

The other way of viewing Heising modulation is based on the behavior of vacuum tubes. Both the modulated stage and the amplifier producing the modulating signal are fed from the same power supply, through the same series choke. When no modulating signal is present, both tubes are furnished the same supply voltage and each draws the current determined by its own operating conditions.

When the grid of the modulating tube goes less negative, that tube draws more current. The additional current through the choke produces a voltage drop and reduces the voltage available for *both* tubes at the same time. This cuts down the power available to the modulated stage and so reduces its output. When the grid of the modulating tube goes more negative, the tube draws less current. The reduced current through the choke releases energy from the choke's magnetic field and raises the voltage available for both tubes. The modulating tube has no use for the increased voltage, so the effect is to raise the power input to the modulated state, and thus increase output.

This second viewpoint indicates that a large part of the action of Heising modulation could be accomplished by using a large resistor instead of the choke – and this can be done. In low-power equipment where both space and cost are important, Heising modulation with resistor instead of choke can be used. The percentage of modulation obtained when this is done depends upon the ratio between the current drawn by the modulating tube and that drawn by the modulated tube. If the modulating tube draws less current, modulation percentage remains comparatively low. If the modulating tube draws more current than does the modulated stage, though, it's even possible

to overmodulate.

Some circuits used for screen modulation, incidentally, amount to the application of the Heising technique to just the screen of the modulated stage. A notable example is that known as "clamp-tube" modulation, which uses the Heising technique with a resistor rather than a choke.

Cathode modulation, which is sometimes employed, is a cross between grid and plate modulation, because in most amplifiers the cathode is common to both the grid and the plate circuits. It shares most of the disadvantages of grid modulation and achieves few of the advantages of plate modulation, and so has not found its way into general use.

Now that we've looked at the various ways to produce AM by varying the amplitude characteristic of the carrier, let's turn our attention to FM and PM. Since the output signals produced by FM and PM are so similar, we'll look at these types of modulation together.

We produce FM by varying the frequency of the carrier, and PM by varying the phase. However it's not possible to change the frequency of a signal without at the same time changing its phase, nor can we change the phase without an accompanying change of frequency. This makes the difference between FM and PM largely a matter of definition; the distinction normally used is that FM can be applied only to the oscillator, while PM is applied to the signal once its center frequency has been firmly established.

The frequency of any *rf* carrier is established by a resonant circuit of some sort in the oscillator. This resonant circuit may be electromechanical, such as a quartz crystal which uses mechanical resonance to produce an electrical signal, or it may be electronic, such as a normal *lc* tuned circuit. To vary the frequency, we must vary some factor in this resonant circuit.

One of the most convenient ways, today, to produce FM is to make use of the voltage-variable capacitor – a semiconductor device which acts as a capacitor, but the capacitance of which varies with the applied voltage. If one of these is included in an *lc* circuit to provide a part of the tuning capacitance, the modulating signal can be

applied to it to change the tuning of the circuit in accordance with the variations of the modulating signal. This changes the oscillator frequency and produces FM.

The voltage-variable capacitor is a relatively recent device, however, and a more conventional method of producing FM makes use of a special vacuum-tube circuit called a "reactance modulator" or "reactance tube" to accomplish the same purpose.

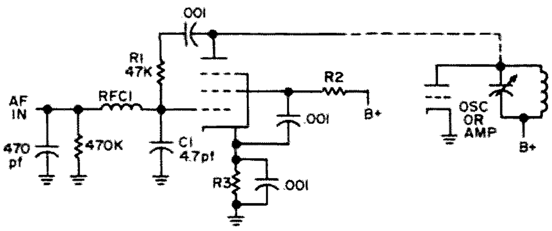

Fig. 10. Typical reactance–tube circuit is shown here. See text for details of operation.

The reactance modulator circuit, a typical version of which is shown in Fig. 10, depends upon the phase relationships between grid and plate voltages and currents in a vacuum tube. Under most operating conditions, the plate current of a vacuum tube is in phase with the grid voltage applied to that same tube, without regard to the phase of the plate voltage.

This means that we can place such a tube in a circuit where ac voltage is present upon the plate, and tap off some of this ac plate voltage. If we then shift the phase of this tapped voltage by 90° and feed it to the grid, the plate current will be 90° out of phase with the plate voltage.

Such a condition defines the presence of reactance in the circuit. If the current lags the voltage by 90°, the reactance is inductive, and if the current leads the voltage by 90°, the reactance is capacitive.

In Fig. 10, resistor R1 and capacitor C1 perform the voltage tapping and phase shifting actions, and cause the reactance in the plate circuit to be inductive.

The *amount* of reactance present depends upon the ratio of plate voltage to plate current, and the plate current is determined by the tube's transconductance (which is, in turn, determined by its grid voltage). If we apply our modulating signal to the control grid, through *rf* choke RFC1 which keeps the tapped-off plate voltage out of any earlier stages in our modulating-signal chain, we can make it control the plate current and thus change the amount of reactance present in the plate circuit.

And that's exactly what we do in the reactance modulator. The net effect is that we have a circuit which acts as either a voltage-variable inductor or a voltage-variable capacitor (to make it act as a capacitive reactance rather than inductive, we simply interchange the positions of R1 and C1 to shift the grid voltage phase 90° in the other direction). The resulting device is then connected across the frequency-determining tank circuit of the oscillator. When the reactance tube changes the reactance present in the tank circuit, the circuit is instantly tuned to some different frequency – and the exact frequency to which it is tuned is determined by the modulating signal applied to the reactance-tube input terminals.

If we connect a reactance tube, or a voltage-variable capacitor, to the frequency-determining tuned circuit of an oscillator, we can produce FM. This is not, however, the only application of the reactance tube. If we want more frequency stability than we can get with an *lc* oscillator, and use crystal control to generate the carrier, then we have to use PM rather than FM – and the reactance tube can give us that, as well. All that's necessary is to connect it across a tuned circuit in the *rf* amplifier chain between oscillator and antenna. Its reactance variations will detune the circuit to which it is connected, and this will change the phase of the signal to produce PM.

The reactance tube also finds application in some receiver circuits, to provide automatic frequency control; the combination of a reactance modulator and a self-excited oscillator is sometimes called a voltage-controlled oscillator or VCO. The VCO is the heart of the advanced receiver technique known as "synchronous detection" or "phase locked reception"; it's also a key element in a TV receiver where it helps keep the sweep signals synchronized with those of the transmitter.

Use of voltage-controlled circuit reactances such as the voltage-variable capacitor

or the reactance tube isn't the only way to achieve either FM or PM. Any practical oscillator circuit is, potentially, a frequency modulator, because the frequency of the signal it produces is affected by any change in circuit voltages. This is why we must regulate the voltages applied to the oscillator in order to keep frequency stable. If we want FM, we can simply reverse things and apply any of the amplitude modulation techniques to the oscillator itself. This will cause frequency changes which are determined by the modulating signal. The amplitude changes which result can be wiped out by overdriving the following amplifier stages, so that only FM comes out at the antenna. We can produce PM by doing the same thing to an early amplifier stage, but it's more critical.

These aren't the only techniques of achieving FM or PM; in the broadcast industry a special type of tube is often used which produces PM almost automatically, and one of the most popular ways of achieving broadcast FM is that invented by Major Armstrong and known as the "Armstrong method." It's used sometimes by hams, too, who are set up for SSB AM modulation using the phasing technique and want to produce PM as well. However, this method is based largely upon mathematical relationships and a knowledge of it isn't required in the Extra Class study questions, so we'll bypass it for now.

Neither will we examine the production of SSB, DSB, or any of the suppressed-carrier modulation techniques at this point, since they are sufficiently complex to warrant their own separate discussion in a future installment.

What Are The Characteristics Of A Modulated Signal? We've seen that modulation itself consists of any process for varying the characteristics of a carrier signal to permit a modulating signal to be transmitted, and we've looked at both the characteristics of the carrier which we vary, and at a number of techniques for varying them. How about the characteristics of the modulated signal, which results from this process?

Like the carrier, the modulated signal possesses three major characteristics – amplitude, frequency (or period), and phase.

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Unlike the carrier, though, the modulated signal never consists of only a single frequency – and so its characteristics are notably different. The difference is, in fact, what carries the information!

It's only logical to deduce from this that the modulated signal's characteristics should be strongly influenced by the type of modulation used, and they are. Because the type of modulation employed has such an effect upon the various characteristics of the modulated signal, we'll look at the characteristics as they appear with different types of modulation separately.

Amplitude modulation is still the most widely used type, and in addition we've considered it first all the way through this installment, so we'll examine the characteristics of an AM signal first and then turn our attention to FM and PM.

In our previous installment we examined the how and why of mixer action, and discovered that when two signals of different frequencies are mixed (as opposed to linearly amplified) the result is not two, but four frequencies. The two original frequencies are still present in the output, but together with them are one new frequency representing the difference between the two (and so known as the "difference" frequency) and another new frequency which is the sum of the original pair (called the "sum" frequency).

The process of amplitude modulation *is* a mixing process; any circuit which is capable of modulating a carrier frequency is non-linear, and when two or more frequencies are applied to a non-linear circuit, mixing occurs.

Thus when we apply our carrier to an amplifier stage, and apply our modulating signal to that stage also, the output of that stage must contain at least four frequencies rather than just two. If the modulating signal is anything more complex than a simple single sine-wave, as it usually is, there are many more than four frequencies present in the output.

Since the modulator does its job by mixing, the output must contain signals at each of the original input frequencies, at their sum, and at their difference.

Normally, though, a modulator is used to apply audio-frequency information to a radio-frequency carrier. In this case, the *af* modulating signal will be at a frequency so far below that of the carrier that no trace of the audio signal itself can appear in the amplifier's output circuit; it's rejected by the tuned circuits.

The sum and difference frequencies, though, are extremely close in frequency to the carrier. If we're modulating a 1-mhz carrier with a 100-hz audio signal, then the difference frequency will be at 999.9 khz and the sum will be at 1000.1 khz. These are so close to the carrier that most tuned circuits which accept the carrier will also accept the sum and difference frequencies.

Since these two new signals lie very close to, and on both sides of, the carrier, they are known as "side frequencies." The name dates from the early days of radio, before it was generally realized that modulation and mixing were one and the same effect.

When a band of many frequencies composes the modulating signal – the normal case with voice signals – then the sum and difference products alongside the carrier are no longer called "side frequencies"; instead, they are known as "side bands." Within the past several years, the two words have blended into one, and we know these parts of the modulated signal now simply as "sidebands."

The lower sideband corresponds to the difference frequencies, and the upper side-

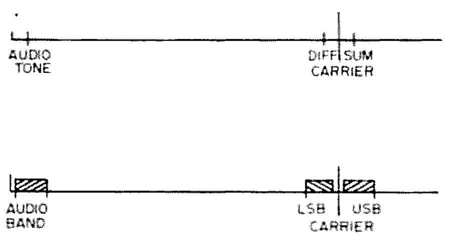


Fig. 11. Side frequencies are generated by mixing or modualtion whenever two input signals are so widely separated in the spectrum as are af and rf. Difference signal is lower in frequency than carrier, and sum frequency is higher. When an audio band, rather than a single spot frequency, is applied to mixer or modualtor, output consists of carrier and two sidebands. Lower sideband (LSB) corresponds to difference frequencies, and upper sideband (USB) to sums. Total signal bandwidth extends from lowest frequency in lower sideband to highest frequency in upper sideband, or twice the highest frequency in the original audio band.

band to the sum frequencies, produced by mixing the carrier with each component of the modulating signal. Fig. 11 shows a single pair of side frequencies (top) and a typical set of sidebands (bottom) as they might be viewed on a wide-range spectrum analyzer.

In passing, we noted in our previous installment that mixing action comes through a multiplication of one signal by the other. If each of the signals applied to a modulator (the carrier and the modulating signal) are described by their equations, the result in each case is a mathematical expression involving the sine of the amount of time since "zero time." If the two are multiplied, the trig relationships involved in multiplying one sine function by another produce an equation with one sine term and two cosine terms; the sine term turns out to represent the carrier, and the cosine terms represent the sum and the difference frequencies. All of this math was worked out in the mid-1920's – but at the time the "side frequencies" and resulting sidebands were thought to be a mathematical fiction. The experts felt that they couldn't possibly exist, but they were necessary to make the math work out properly.

Then in 1927 John Carson demonstrated the physical existence of the sidebands, and took out a patent on a system of single sideband transmission. The math was vindicated; unfortunately, it's still not an accurate picture of what goes on, because the mathematical expression fails to account for the original modulating signal.

Much later it was realized that modulation and mixing are two names for the same process (at least so far as AM is concerned), and the body of theory developed to describe mixer action was applied. Many college-level engineering texts still, however, teach modulation without going into its connection with mixing.

The references generally available to most hams, though, are even less clear, because many of them leave the impression that the amplitude of the carrier is varied to produce amplitude modulation.

In fact, we've even implied as much ourselves – and its time to correct that idea.

We saw just a few paragraphs back that the sidebands lie very close indeed to the

carrier in the frequency spectrum. For all practical purposes, the two sidebands and the carrier together constitute a single signal, because most receivers are not sufficiently selective to strip out any part of this combination from the rest of it.

But when this composite signal is applied to any electronic circuit, there's only so much energy present in that circuit at any specific instant. That is, the energy present in the circuit is the net total of that contributed by the lower sideband, the carrier, and the upper sideband, all at the same time. If the energy in the sidebands is of just the right amount and polarity to completely cancel the energy of the carrier, this net total will be zero, and on the other hand if the same amount is contributed but with polarity to boost rather than buck the carrier level, the total will be twice as much energy or four times as much power as with the carrier alone.

The variations of net energy in the *total* signal produced by the amplitude and polarity changes of the sidebands relative to the carrier are called the "modulation envelope" or simply the "envelope" of the signal – and in amplitude modulation it's the amplitude of the *envelope* rather than that of the carrier which varies.

The distinction is more theoretical than practical, because as we said, it's almost impossible to separate parts of the composite out with most receivers. A "selectable sideband" receiver, though, has the ability to accept or reject a single sideband of an AM signal, and the whole art of SSB is based on the fact that all the modulation information is contained in the sidebands, and that the sidebands are mirror images of each other so that only one is necessary to carry all the information.

Fig. 12 shows the envelope of an AM signal over a half-cycle of modulating signal. This is not typical since only a 3-to-1 ratio between carrier and modulating frequencies was used, in order to permit easy vision of the relationships between net energy in the composite signal (dotted line) and the envelope (solid). Normally the frequency ratio is much higher. Like all the other waveform illustrations in this installment, this figure was traced from a plot produced by an electronic computer.

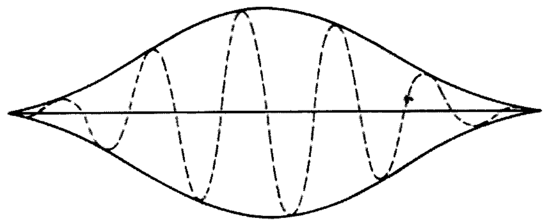


Fig. 12. Envelope of AM corresponds to the peaks of the energy levels present in the combined carrier and both sidebands (dotted waveform). This illustration shows a full cycle of modulating signal from negative peak to the next negative peak, with six cycles of carrier/sideband.

The relationship in strength between either sideband and the carrier is a measure of an AM modulation system's effectiveness. The stronger the sideband, as compared to the carrier, the more effective the system.

This relationship is usually expressed by engineers as the "modulation index" of the modulated signal, but hams and the FCC refer to it in a slightly different form called the "percentage of modulation." This, again, is a carryover from the days when only the envelope was considered – and as a result the definitions of modulation percentage make very little sense when applied to a suppressed-carrier signal, and none at all when applied to FM or PM.

For "percentage of modulation" is determined by the ratio of peak envelope voltage (or current) to the carrier voltage (or current) without modulation. Fig. 12 shows these parts of the envelope. The carrier level is indicated by the dotted line.

Percentage of modulation may be different for "upward modulation," which is the half-cycle of the modulating signal which produces the positive modulation peak, than for "downward modulation" which produces the negative modulation peak. For sine-wave modulation both are the same, but for voice the two are normally different. The larger of the two figures is customarily used as the modulation percentage of the signal.

In the case of upward modulation, the modulation percentage is 100 times the ratio of the positive modulation peak (above carrier level, as shown) to the carrier level. In Fig. 12, both are equal and the ratio is 1/1, so the modulation percentage upward is 100%.

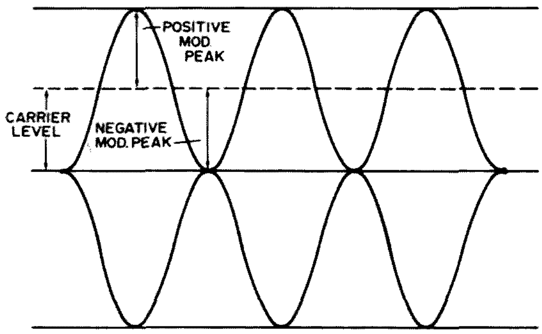


Fig. 13. Key factors involved in calculating percentage of modulation are identified here. Wave form represents 100% modulated envelope (carrier cycles are not shown) as described in text. Carrier level furnishes zero reference for envelope; envelope's outline duplicates modulating signal on both edges.

For downward modulation, the percentage is 100 times the ratio of the negative modulation peak (below carrier level) to the carrier level. In Fig. 12, again both are equal so the ratio is 1/1, making the percentage again equal to 100%.

FCC regulations limit modulation percentage of an AM signal to 100% in either direction. There's very good reason for this in the downward direction; 100% modulation justs cuts off the envelope at zero energy. Anything in excess of 100% modulation represents an effort to make the envelope less than zero; it doesn't work. What happens is that the negative modulation peaks are highly distorted, and this distortion produces spurious signals which clobber communications over a wide spread of the frequency spectrum. See Fig. 13.

Modulation percentage is relatively inapplicable to SSB or DSB, since these signals have no "carrier level" to measure against. We'll find out why it's not applicable at all to FM or PM a little later.

When you understand how modulation percentage is defined, it's not too difficult to visualize the envelope of a sine-wave-modulated signal at any prescribed percentage of modulation. Simply establish a carrier with a peak voltage of, say, 10, and then sketch in the modulating sine-wave along the carrier level. Positive peaks of the modulation envelope will rise above carrier level by the modulation percentage times the carrier level; that is, with a 10-volt carrier and 50% modulation, positive peaks will rise to 15 volts. Negative peaks will drop below carrier

level by the same amount; in our example, to 10-5 or 5 volts.

If the percentage exceeds 100%, positive peaks still go up in the same way, but negative peaks cut off at the carrier zero reference line to produce a distorted envelope.

We have seen how all of the information content of the envelope is produced by the sidebands, in AM. We have also seen how the sideband energy levels produce the envelope of the signal. It shouldn't be too surprising to learn that all of the power furnished by the modulating signal goes into the sidebands.

Strictly speaking, that's true only of plate modulation, because that's the only type of modulation we've examined in which the input power is varied to produce modulation. But with plate modulation, that is what happens. The amplifier treats the carrier the same at all times, whether modulation is present or absent. When modulation is applied, the modulating-signal power produces the sidebands.

We also saw that 100% modulation is produced when the sidebands have just the right amount of energy to completely cancel out the carrier energy at the negative modulation peaks. Because of some rather complicated phase relationships, this occurs when each of the two sidebands has peak voltage equal to half that of the carrier. Then the two sidebands each contribute half, and the total exactly balances out the carrier.

With half the voltage in each sideband, this means that each sideband must contain 1/4 as much average power as does the carrier in order to attain 100% modulation with a sine-wave signal. To put 1/4-carrier-power levels into each of two sidebands requires that the modulator supply power equal to half that in the carrier.

Should we reduce the modulation percentage, the amount of power required in the sidebands would also be reduced. Should we use something other than a sine wave as a modulating signal, as for example normal speech, we could also get by with less power. As a rule of thumb, though, most designers try to furnish half as much audio power as there is going to be *rf* power in the carrier. This offers a safety margin, and also permits speech processing such as clipping and compression without running short of modulating power.

Because the carrier level remains constant with plate modulation, which is the most popular kind, many people believe that carrier level is always constant with modulation. This is not necessarily so.

When AM is achieved by varying efficiency of an amplifier, as is done in all types of grid modulation, it's simply the designer's choice as to whether carrier remains constant, or varies with modulation. Many designers of such systems have attempted to produce output indistinguishable from that produced by plate modulation – and in these systems, carrier remains constant.

Other designers, though, have chosen to control the carrier level. All controlled-carrier systems (a notable example is a Heathkit design originally introduced about 1955 and still current) produce carrier levels which vary with the intensity of the modulating signal.

Even in these, though, the ratio of power between carrier and sidebands remains fixed by the modulation percentage.

Now that we've given AM signal characteristics a thorough going-over, let's see how FM and PM differ.

For a starter, the envelope of an FM signal carries no information. In fact, a legal FM or PM signal has no envelope variations at all, because that would constitute AM and the rules don't permit mixing the types.

FM and PM signals do, however, have sidebands – many more sidebands than are produced by AM at the same modulation index. Most texts drop into a deep and somewhat murky study of Bessel functions when they attempt to discuss the distribution of sidebands in FM signals. Since we don't, at this point, need all that information, let's skip the details of how they are produced and simply note that the visualization most of us carry of an FM signal – a single carrier which wanders about in frequency around a "center" frequency, and whose wanderings carry the modulating signal information – is no more accurate in detail than is the conventional view of an AM signal as one whose strength varies with

modulation. See Fig. 14.

In both cases, it's the *envelope* characteristics which vary rather than those of any specific components within the signal.

This comes about because a signal of any one frequency cannot be at any other frequency – and it can't get from one frequency to another without getting to one in between first. When it's necessary to analyze in detail how a modulation system works, it's more convenient to view the signal as being made up of many signals each of specific frequency and strength, which are either present or absent, than it is to try to consider *one* signal of varying frequency or strength.

Since the advent of SSB, it's become necessary to examine AM in this amount of detail. When looking at FM, we can get by with studying only the behavior of the envelope; we don't have to break down the various components within the envelope.

The FM signal is characterized by its center frequency, strength, and the amount of deviation above and below this center frequency. The deviation may be expressed either as an absolute frequency difference in hertz or khz, in which case it's called "swing," or as the "deviation ratio," which is the ratio of the maximum carrier-frequency deviation to the highest modulating frequency. The effectiveness of the modulation is measured by the "modulation index," which is the ratio of the carrier frequency deviation to the modulating frequency. That is, a 3-khz swing with a 1-khz modulating frequency would produce a modulation index of 3; the same swing with a 6-khz modulating frequency would produce a modulation index of 0.5, and if the 3-khz swing were the maximum employed in the system, and the 6-khz signal the highest frequency, then the deviation ratio would also be 0.5.

In ham use below 52.5 mhz, the maximum bandwidth which an FM signal is permitted is 6 khz (the same as a state-of-the-art AM signal). If frequency response is limited to 3 khz, then the deviation ratio would be 2; the modulation index would vary with the modulating frequency, from 2 at the high-frequency limit up to 20 at a 300-hz modulating signal.

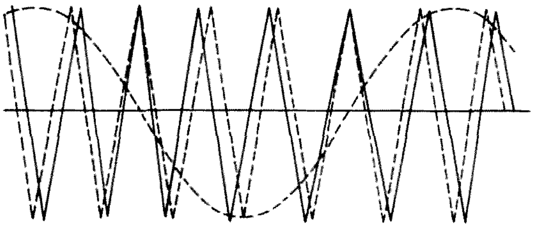


Fig. 14. This composite view shows an FM signal's waveform (solid line), compared to that of an unmodulated carrier of the same center frequency (dotted) and to the modulating sine-wave (also dotted). Sine-wave shape of carrier and modulated-signal waveforms has been simplified to straight line connecting peaks and passing through axis at proper zero-crossing time.

In AM, modulation index is the ratio of modulation peak level to average carrier level – the same quantity which we multiply by 100 to obtain modulation percentage. A 100% modulated AM signal has a modulation index of 1.0. Modulation percentage is sometimes defined, in fact, as 100 times the modulation index.

This is part of why modulation percentage has no meaning in FM work. Modulation peaks are always at the same level as the average carrier level, and by conventional definitions all FM has 0% modulation. But if 100 times modulation index is used, then the modulation percentage of a legal ham FM signal may vary from 200 up to 2000%, depending upon modulation frequencies present.

In practice, the deviation ratio is used to measure FM in the same way modulation percentage is used for AM.

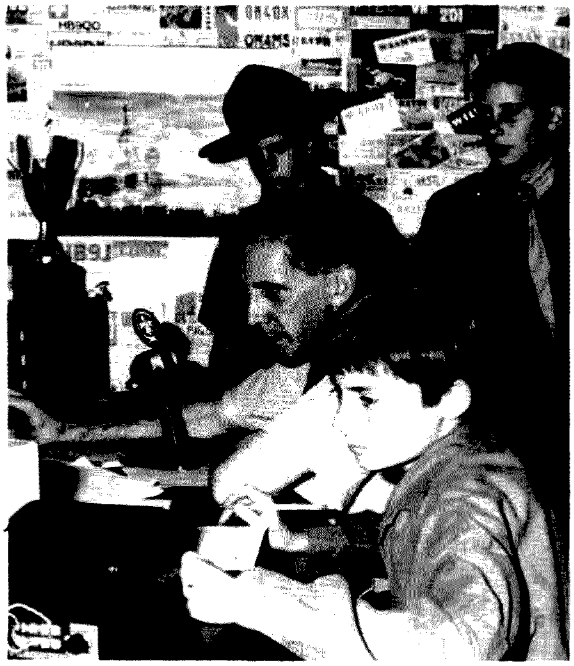
But while it's possible, physically, to overmodulate an AM signal and produce splatter, this cannot be done with FM. An FM signal with more swing than a receiver is designed to accomodate will sound distorted on that receiver – but will be fine on any receiver which can handle the maximum swing of the signal. The limits on swing of an FM signal are administrative, while those upon modulation percentage of AM are physical. ... 73 Staff

Ed Gribi WB6IZF
229 Vivian Street
King City, CA

Ham Jamboree

Editor Wayne waxed eloquently in July 73 about the need for attracting newcomers into our hobby. One of the largest groups of ready-made potential newcomers are the ten million or so Boy Scouts around the world. There are a number of points of contact between scouting and amateur radio, but one of the best is the annual "Jamboree On The Air."

What is Jamboree On The Air? Let me try to describe its background, purposes, and format for you from a very personal standpoint. I had the good fortune to be one of the operators at K7WSJ, the official amateur station at the World Scout Jamboree at Farragut State Park, Idaho, in August, 1967. Those ten days were one of the high points of my 43 years. Meeting Lady Powell; the night the entire Australian contingent jammed our shack as we worked VK after VK (no third party traffic, please!); the colors of the tents and banners against the green Idaho forest; the Belgian Scout who brought his sleeping bag into the shack in the hope we could work an ON; the myriad of colorful uniforms and thousands of smiling faces thoroughly enjoying one of the great experiences of their lives. These and hundreds of other thrills and pleasant memories will always be with me. I made many lasting friendships from a dozen different countries and still exchange letters with several of them. But I was one of the lucky ones. Fewer than 1% of the Scouts are able to attend a World Jamboree or one of the greatest national or regional jamborees. Therein lies the reason for the development of Jamboree On The Air.



Scouts at Geneva, Switzerland. Operator is Len Jarrett, HB9AMS, Director of Administration, Boy Scouts World Bureau.

A number of Scouts operating the amateur station during the World Jamboree in England in 1957 were concerned that so few Scouts of the millions could actually participate in the face to face building of international friendships. Perhaps radio could extend the reach of the brotherhood and involve more Scouts, even if vicariously, in such events. Les Mitchell, G3BHK, conceived the idea of a Jamboree on the air and the first formal JOTA was in May, 1958. The idea has mushroomed with the aid and abettment of enthusiastic Scouts, Scouters, and amateurs so that now thousands of

stations from every Scouting country participate in the event every year.

The primary purpose of JOTA, therefore, is to enable Scouts everywhere to talk to other Scouts across town or around the globe by radio. A secondary purpose is to give them exposure to amateur radio which may help a boy discover a latent career in electronics or some allied field, or perhaps in amateur radio as a hobby. It has undoubtedly encouraged many a boy to work on related Scouting accomplishments such as radio and other merit badges.

The 12th annual Jamboree On The Air will occur October 18 and 19, (GMT), 1969. Participating stations with Scouts and Scouters in their shacks will be calling "CQ Jamboree" on all bands and modes during that period. There are no rules nor points to count–this is *not* a contest! The theme is to let *Scouts talk to Scouts* wherever they may be. There are no formal fixed frequencies, but the Boy Scouts World Bureau has recognized traditional operating practices by noting the following as "World Scout Frequencies":

3,590 khz. – CW
3,740 khz. – European phone, U. S. Novice CW
3,940 khz. – U. S. phone
7,090 khz. – CW, European phone
14,090 khz. – CW
14,290 khz. – phone
21,140 khz. – CW, U. S. Novice
21,360 khz. – phone
28,190 khz. – CW
28,990 khz. – phone

In addition, U. S. amateurs have found 7290 khz to be a good frequency and 7190 khz a good CW frequency for novices.

If you, as an amateur and/or Scout or Scouter are not already involved, then perhaps this should be your year for Boy Scouts. You might contact a local Scout office or executive or, even better, a Scoutmaster or Den Mother or Patrol Leader. They may not be familiar with the event unless they are avid readers of "Scouting," "Boys Life," or "World Scouting." You may have to explain the purposes and what they might reasonable expect from participation (remember, though, that propagation may not cooperate). In many areas amateurs talk to Scout Troops several weeks before the event to explain such things as how we're able to communicate hundreds or thousands of miles, typical terminology involving equipment and operating, and perhaps even to arrange a preliminary visit to a station.

During the event get your amateur operating exchanges out of the way as briefly as possible. Then turn the boys loose and let them talk to other Scouts. If they're a little tongue-tied at first, encourage them to talk about such things as themselves and their own personal involvement in Scouting; their Patrol, Troop, Post, or Den; their camping and other activities; their home, town, area, and its culture and environment; and, of course, to ask similar questions of those on the other end. Don't feel like you have to hurry off to make more contacts or to let them talk to some exotic DX Scout station. It is much more meaningful and closer to the purposes of the event to have a two-hour ragchew with a gang 100 miles away than it is to exchange signal reports with stations in ten countries. I've listened in on some marvelous QSO's during past events where, for instance, a couple of Patrol Leaders in different parts of the USA exchanged notes on their summer camp experiences or Tenderfeet talked about their first hike. On the other hand, if conditions are favorable it can be a real thrill for them to talk "live" to a Scout in some foreign country. The language barrier is no barrier when international friendship is involved.

When it's all over the very least you'll have is a lot of satisfaction in having associated with a fine group of young men. I know it always restores my faith in the basic good sense of our youth whenever I get around a group of Scouts. Beyond that there are several things that can be done that will extend the interest period and firm up the relationships begun. Encourage the Scouts to make up and send QSL cards to the groups they talk to and perhaps to initiate correspondence or exchange of photos. Many permanent overseas links between Scouting groups have begun this way. And by all means send a note regarding your JOTA activities (including contacts and critique) to your National Organizer (in the United States it's Harry Harchar W2GND, Boy

Scouts of America, New Brunswick, New Jersey 08903) with a copy to the World Organizer, Len Jarrett HB9AMS, Boy Scouts World Bureau, Case Postale 280, 1211 Geneva 11, Switzerland. Len is an enthusiastic participant in JOTA's and will again this year be operating from 4U1ITU until a permanent World Bureau station can be set up. World Scout Bureau will send you a handsome QSL-sized ceritficate of participation in return for your courtesy in telling them of your own activities.

So you've done all these things but it still seems like the contact between amateur radio and Scouting should be more than a once-a-year thing. I always have that feeling myself. There's no reason why you couldn't continue the relation with a particular Scouting group with such diverse projects as teaching them code, providing communications at a Camporee or camp, or maintaining schedules with someone contacted during JOTA. There are several nets devoted to Scouting in various portions of the world. G3BHZ and HV3SJ operate on 14290 khz on Saturdays at 0930 GMT, mostly with other European participants. World Scout Net operates on 21360 khz at 1800 GMT on Saturdays. Bob Hallock WA7GOO, is the prime mover in this group. Bob was an operator at K7WSJ in 1967 and at the National Jamboree station this last July. Bob is an Eagle Scout from Boise, Idaho. and has injected a lot of enthusiasm into the WSN. These groups are devoted to the furtherance of the ideals of Scouting via amateur radio and as such deserve support and participation by all with similar aims.

I have one suggestion regarding JOTA

Australian Scouts at VK2BW during the 1968 JOTA.

At Baden Powell House, London—English Scout headquarters.

operation this year that I haven't even cleared with Len Jarrett at the World Bureau. Let's try using these World Scout Frequencies as calling frequencies during JOTA instead of ragchew frequencies. In other words, call "CQ Jamboree" on the frequency, then QSY up or down for a QSO. That way there would be much more efficient utiltization of frequency space and much less random calling. Perhaps we could even have net control stations active on one or more of the frequencies, particularly 21,360 khz. I imagine Bob WA7GOO, could organize two or three net controls to pick up breaks, periodically call a list of stations and localities on the frequency, and help stations who wish to QSY for a chat. I'll see if something like this might be arranged by the time this appears in print. During other times these frequencies should make natural frequencies for any stations interested in Scouting to get together.

So there you have the story of Jamboree On The Air. If you're interested in young people and in the health of amateur radio, this should be a regular event for you. If you feel as I do that once a year just whets your appetite, then you might follow some of these other suggestions that could lead to a Jamboree On The Air the year round.

. . . WB6IZF

Reference:

"Scouting and the Radio Amateur," QST, July, 1967, p.52, WB6IZF

NEW PRODUCTS

Two Meter Transceiver

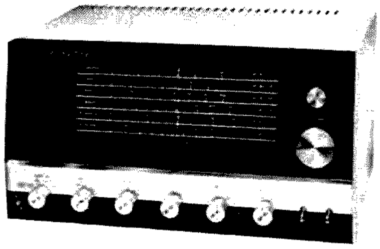
Many amateurs, tired of using older taxi and police FM equipment, have been looking for reasonably priced new equipment to come on the market. Varitronics has just announced a new solid state FM transceiver designed and priced for the amateur market. It has six crystal controlled channels and runs from 12-15 vdc. The power is 10 watts input. The unit is built with sub-printed circuit boards of the computer module type, making the unit small enough for easy portable and mobile use.

Varitronics also has a one watt output unit available which can work with a battery pack, a six meter crystal controlled FM transceiver and a dual vfo six meter AM-FM transceiver. Write to Varitronics, 3835 North 32nd Street, Suite 6, Phoenix, AZ 85018.

More Power for FM'ers

Varitronics Inc. has come out with two new linear amplifiers for users of their deluxe FDFM-2 transceiver.

For the mobile enthusiasts, the completely solid state FM-20M mobile rf linear amplifier can be had for $150.00, weighs but a pound, requires12.5 vdc and can boost your mere 2 watts to 20 watts input and 10 watts rf output. For those using the FDFM-2 transceiver as a home station, you might look into the new FM-20BM, available for $235.00. It weighs 6½ pounds, is completely solid state, has a built-in ac power supply requiring 117 vac, and like the FM-20M mobile model, can increase 2 watts input to 20. For further information, write Varitronics Inc., 3835 North 32nd Street, Suite 6, Phoenix, Arizona 85018.



Now the HA-800

Lafayette introduces the new completely solid-state, model HA-800 six-band SSB/AM/CW amateur receiver. This 80-6 meter amateur receiver has a built in dual solid state power supply permitting either 117 volts ac or 12 volt dc operation with zener regulation. The receiver section sports 3 FET's and 2 mechanical *if* filters to assure high selectivity with superior noise suppression. An S meter, product detector and crystal calibrator (less crystal) are among the other features. Specifications: sensitivity: better than 1 uv on 80, 40, 20 meters, .5 uv on 15, 10 meters and 2.5 uv on 6 meters; selectivity: -6db at ±2 khz, -60db at ±6 khz; intermediate frequencies! 1st *if* 2.608 mhz, 2nd *if* 455 khz; BFO frequency: 455 khz ±2.5 khz; image rejection: better than -40db; audio output impedance: 50 ohms; power requirements 105-120 volts 50/50 hz ac, 12 volts dc (negative ground); size: 15w x 9¾d x 8¼h. For additional information, write Lafayette Radio Electronics Corp., 111 Jericho Turnpike, Syosset, L.I., NY 11791.

FMT-1 FM Transceiver

VHF Associates, Inc., is now offering a six channel, 5 watt input FM transceiver for $289.95. It operates with a dc input voltage of 12 to 15 volts and weighs but six pounds, being fully transistorized. IC's are used in the if and audio circuits for superior perfor-

mance and reliability and the receiver is dual conversion. The transmitter has a 20 khz maximum deviation and has a frequency range of 142 to 149 mhz. For further information, write VHF Associates, Inc., PO Box 22135, Denver, CO 80222.

Arcturus

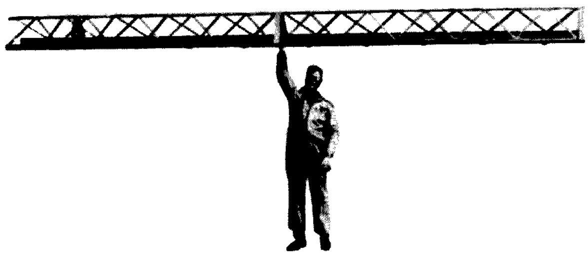
Arcturus Electronics Corp. has been lucky enough to acquire 9800 obsolete tubes, circa 1925-1930, to add to their considerable inventory of the same hard-to-obtain types. Listings plus prices of thousands of other items are included in their recently published Mid-1969 Catalog, which they will be glad to send to you without any obligation on your part. Write direct to Arcturus, 505-22nd St., Union City, N.J. 07087.

Cassette Albums Available

Now that more and more of us are using cassette tape recorders to tape our friends and unusual DX contacts, the problem of storing those little cartridges begins to intrude. They are a terrible size to store and they soon rattle around in the desk drawer. Robins Industries, College Point, N.Y. 11356, has come out with a nice album. Each cover holds six cassettes and each compartment has a built-in stop to keep the tape from going slack! The cost is $3.30 each. A bargain.

Microflect Towers

Aluminum towers may be harder to manufacture, but they sure have a lot of advantages for the fellow who has to put



them up and use them.

First of all, of course, they weigh but a fraction of what we are used to with steel towers . . . about one third as much. A ten foot section weighs only 12½ pounds! This may not mean a whole lot to you when you are dawking it around on the ground, but when you are putting the sections one on top of the other up in the air you will bless every last pound that you don't have to struggle into place.

The weight makes an enormous difference if you have your tower hinged at the bottom for easy work on the beam and rotator. It's the difference between walking a 72 pound, sixty foot tower into place and walking a 212 pound monster into place. One man vs. maybe three to do the job.

Some towers are just terrible for climbing. Those diagonal struts hurt the feet and are dangerous if at all damp. The Microflect tower is different. Some genius thought ahead a little bit and decided that it would be a good idea to build flat step segments into each brace. The result is a tower that you can walk right up.

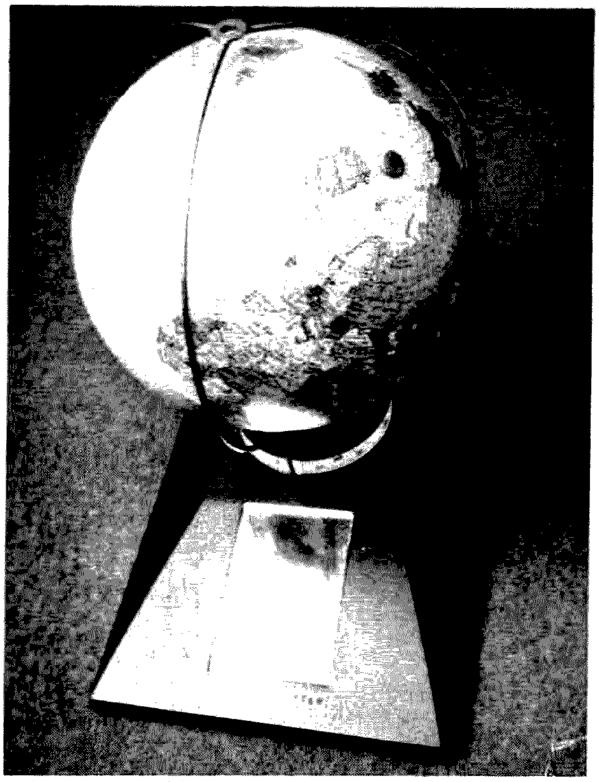
Aluminum towers can't rust, of course, and never need any paint. They look great when you put them up and look just as great years later.

For a catalog and prices send to Microflect, 3575 25th S. E., Salem, OR 97302.

73 Tests the Globeplotter

One of the cleverest ideas for beam aiming at DX to come along in recent times is the Megert Globe Plotter. This consists of a six inch world globe sitting up on a pedestal with a beam-path indicator.

To use this gadget all you have to do is turn the globe so that your station location is beneath the locating circle on the top of the stand. Then, as you turn the pedestal, you can read the beam heading of any city that falls under the beam-path indicator. Charts and regular world globes are all well



and good, but there is absolutely nothing like having a globe mounted with your home on its axis. For the first time you will be able to see how the great circle paths really swing...and how your signals travel. If you've ever wondered why your beam heading is almost the same for Brazil as it is for South Africa, the question will be dispelled when you swing your Globe Plotter around.

And, since the globe is not permanently fixed in place (unless you glue it to the three pillars that hold it to the pedestal) you can easily swing it around to any other location and get the beam heading from there to any other spot in the world. If a station in Germany is working New Zealand, do you think he could here you? The plotter will tell you immediately.

You don't have to scrunch over to see what the other side of the world is like...GP has a built-in mirror for looking at Australia and environs.

The Globe Plotter is just under 10" high and is mounted on a nice looking base. Price is $17.95 by mail order from Megart, Box 2097, Des Moines, Iowa 50310.

PROPAGATION CHART

J. H. Nelson

October 1969

SUN	MON	TUES	WED	THUR	FRI	SAT
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Legend: Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7A	7	7	7	7	7	14	14A	21	21A
ARGENTINA	21	14	14	14	7	7A	7A	14A	21A	2:A	21A	21A
AUSTRALIA	21A	14	7A	7B	7B	7B	7B	7B	14	14	21A	28
CANAL ZONE	14	14	14	7A	7	7	7	14A	28	28	28	21A
ENGLAND	7	7	7	7	7	7A	7A	14A	21A	21A	21	14
HAWAII	21	14	7B	7B	7	7	7	7	14A	21A	28	28
INDIA	7B	7B	7B	7B	7B	7B	7B	14	14	14	14	7B
JAPAN	14	14	14B	7B	7B	7	7	7	7B	7B	14B	21
MEXICO	21	14	14	7	7	7	7	14	21A	21A	21A	21A
PHILIPPINES	21	14	14B	7B	7B	7B	7B	7B	14	14	14B	14
PUERTO RICO	14	7A	7	7	7	7	7	14A	21	21	21	21
SOUTH AFRICA	14	14	14	14	7B	14	14	21A	28	28	21A	21
U. S. S. R.	7	7	7	7	7	7B	7B	14A	21	14	14	7B
WEST COAST	21	14	14	7A	7	7	7	7	27	21	21A	21A

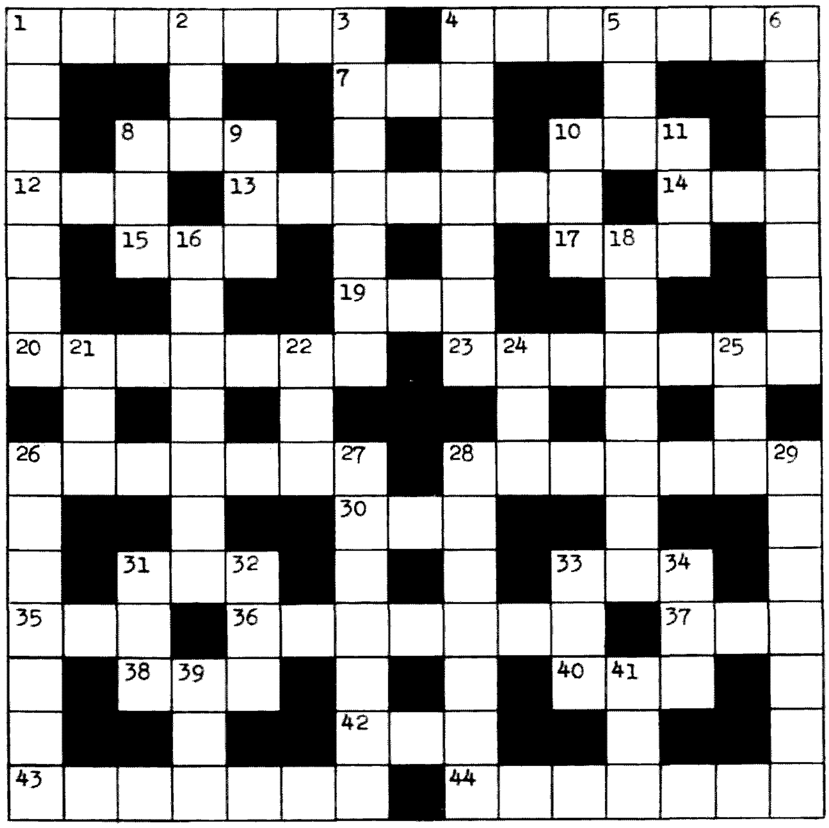
CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	14	7	7	7	7	7	14	21	21A	21A
ARGENTINA	21	14	14	14	7	7	14A	28	21A	21A	21A	21A
AUSTRALIA	28	21	14	7A	7B	7B	7B	14B	14	14	21A	28
CANAL ZONE	21A	14	14	14	7	7	14	21A	28	28	28	28
ENGLAND	7B	7	7	7	7	7B	14	21	21A	21A	14	14
HAWAII	28	21	14	7A	7	7	7	7	14A	21A	28	28
INDIA	14	14	7A	7B	7B	7B	7B	14	14	14	14	14B
JAPAN	21	14	14	7B	7B	7	7	7	7B	7B	14	21
MEXICO	14	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	14	14	7B	7B	7B	7B	7B	14	14	14	21
PUERTO RICO	21	14	7A	7A	7	7	14	21	21A	21A	21A	21
SOUTH AFRICA	14	14	14	7B	7B	7B	14A	21	28	28	21A	21
U. S. S. R.	7B	7	7	7	7	7B	7B	14	14A	14	14	7B

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	14	7	7	7	7	7	14	14A	21	21
ARGENTINA	21	21	14	14	14	7A	7B	14A	21A	21A	21A	21A
AUSTRALIA	28	28	21	14	14	14	7B	7B	14	14	21A	28
CANAL ZONE	21A	21	14	14	7	7	7	14A	21A	28	28	28
ENGLAND	7B	7B	7	7	7	7B	7B	14	21	21A	14	14
HAWAII	28	28	21	14	14	7A	7	7	14A	21A	28	28
INDIA	14	14A	14	7B	7B	7B	7B	7B	14	14	14	14B
JAPAN	21A	21	14	7B	7B	7	7	7	7	7B	14	21A
MEXICO	21	21	14	7	7	7	7	14	21	21	21A	21A
PHILIPPINES	21A	21	14	7B	7B	7B	7B	7B	14	14	14	21
PUERTO RICO	21	14	14	7	7	7	7	14A	21A	28	28	21A
SOUTH AFRICA	14	14	14	7B	7B	7B	7B	14	21	21	21A	21
U. S. S. R.	7B	7B	7	7B	7B	7B	7B	7B	14	14	14	7B
EAST COAST	21	14	14	7	7	7	7	14	21	21	21A	21A

A—Next higher frequency may be useful this period
B—Difficult current this period



Across

1. Also called a ham.
4. Electronic path between 2 or more paths providing a number of channels.
7. Type of tree.
8. Logarithmic expression of ratios of power.
10. Ampere. Abbr.
12. Electromagnetic unit. Abbr.
13. A generator that provides field current for an AC generator.
14. Organ of sight.
15. Megohm. Abbr.
17. Basic unit of work in the cgs system.
19. Period immediately before some event.
20. Surrounding.
23. Used in T.V. receivers to supply high DC voltage required by the second anode of cathode-ray tubes.
26. Chemical compound used to coat recording discs.
28. Audio amplifier frequency equal to the square root of the product of two half-power frequencies.
30. Maiden name.
31. International Radio Association. Abbr.
33. G.I. club.
35. Affirmative side.
36. A type of battery.
37. To move with pressure and friction.
38. Short sleep.
40. Surface between two adjacent grooves on a recording disc.
42. Period of time.
43. A device that introduces inductive or capacitive reactance into a circuit.
44. Process of entering information or answers via the agency of a printer.

Down

1. A means for radiating or receiving radio waves.
2. Short wires used to connect open-line wires to insulators.
3. Stepping relay actuated by an armature-driven
4. Prolonged undesirable opening and closing of elecrtical contacts.
5. Used in mechanical push-button tuning systems.
6. Speaker designed for treble frequencies.
8. Worthless person.
9. A section or branch of a component or system.
10. Unit of surface measure in the metric system.
11. A short pin or bolt.
16. End section of a transistor.
18. Also called diamond antenna.
21. Male nickname.
22. Partner of bolt.
24. Weekday. Abbr.
25. Indefinite period of time.
26. A fitting designed to change the terminal arrangement of a jack, plug or socket.
27. Sometimes called matrix.
28. Absolute unit of pressure.
29. A type of dipole antenna.
31. Atom which has fewer or more electrons than normal.
32. Snake.
33. Stations capable of direct communications on a common channel.
34. A globe or sphere.
39. Discharge of electricity through a gas.
41. Also.

. . . **Michael Kresila**

Solution on page 122

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Operation Cat's Paw

or The Tale of Two Kitties

I should have realized what was going on when those QSL cards would not check out with my log! My memory did not include any recollection of QSOs with those stations, and there were no entries for them in my log book.

Before getting any deeper into my problem, let me explain the W5CA station set-up. My garage-ham-shack is a Santa Fe railroad boxcar, of the old wooden type. It is 44 feet long and makes an excellent garage for my Buick. By adding a partition I made a cozy hamshack and workshop in the end of the old box car. The shack has comfortable old chairs, a battered sofa and, of course, the rig and workbench, plus the usual pile of surplus gear.

The YF and I are cat lovers and have always shared our home and household with cats. Currently we have two furry friends; Golden Nugget 3rd, and Ebony, a jet black cat two years younger than old Nugget who is twelve. Both are fine cats and friends.

Long ago, I thought up a convenient method of letting our cats in and out of their quarters. I cut an opening in an outside wall, overlaid with pieces of canvas to keep out the wind– unwanted dogs, and yet permit the cats to go in and out of their home without bothering us. Such a "cat door" was placed in the box car wall so that the cats would have a snug, warm place to sleep or to hide out. The only human access to the shack is a door that is kept locked to protect the rig from "unauthorized usage". Or, so I thought!

I practice the old habit of leaving all filaments burning on the rig and the receiver fully fired up. All it takes to get on the air is to punch a push-button switch on the table. This energizes the input to the transmitter power supplies. A foot switch, when pressed, completes the relay circuits and the rig is on the air, subject to keying. With the foot switch up, the receiver is back in action. As I said before, I should have known better!

Looking back, I recall that Nugget spent an awful lot of time in the shack. I presumed that both cats slept there at night but, even in the daytime, there was usually a cat snoozing away on the sofa or in one of the old chairs.

Nugget was also a frequent guest on the operating table. This began when he was still a small kitten. He was fascinated by the HRO dial and entranced when the colored pilot light jewels lit up. The Panoramic adapter 'scope pattern seemed to attract his attention and the wiggles of the 'scope pattern almost hypnotized the cat. He would sit by the hour and watch. As he grew older, his long whiskers would twitch as the CW screeched out of the cans perched high on my head. Ebony was not so impressed and gave the rig and its operation scant attention.

Another thing I should have noticed was Nugget's staring at the QSLs pinned on the wall and ceiling. He'd sit by the hour, golden head cocked to one side, peering at the cards with their bright numerals and intricate patterns.

Then one day I added a new one– FE1INE. Shortly after this, things began to happen that were beyond my comprehension. I have always, like most active amateurs, received a few QSLs that would not check out. Even inactive hams sometimes receive them! I'd had my share of unknowns, but now there were more than

normal. I pile up my incoming cards, and some evening when the band is dead I sort them out, check them against the log, record their receipt and then fill out answers.

This one evening there were several cards which would not fit into my records. There were the usual W and K cards, many of which were from guys so anxious to work New Mexico that they overlooked making the necessary QSO first. But there were several DX cards in the pile and they did not show up in the log. This should have been warning enough, but as I said, I was not hep– not yet!

I filed away those inexplicable cards with my collection of swl cards, sighing as I did, for there were some really rare ones in this new group of "unknowns".

A few days later our 5th call area QSL Bureau sent me another batch, and with those cards was a scribbled note from Brad, W5ADZ, our QSL sender-outer and noted DXer. His note read–"OM, you sure have some goodies in this batch. This makes me drool to see such choice morsels go out to you. What special calling formula do you use at Tijeras, or is it merely the altitude? Lemme in on the secret."

I spread out this new batch of cards which had evicted a comment from blasé Brad, who, I thought must have seen everything in the line of DX himself. No wonder Brad had mentioned *these* cards. Here is the list, just as I wrote them down on the back of a log sheet. MEØUW–UR1KAT–CA1TS– PU3SS– MØUSE– YL1KIT–UP1PUS! I was sitting there mulling over these rare cards when I chanced to look over at the old sofa. Ebony was asleep but Nugget was obviously "playing possum". I could see his eyes gleam through narrowed lids. He was far from asleep.! I had been picking up the cards, one by one, examining them, and then I placed them face up on the table. Nugget looked as if he was watching me, so I tested him by holding up the colorful YL1KIT QSL. Nugget's long white whiskers twitched and I could see him drool, as cats do when they are pleased or excited about something. The look in the cat's eyes was enough to tip me off, but how dumb can we humans be? There was still another clue to the mystery but I muffed it, also. At W5CA I use an elapsed-time meter across the ac input to the transmitter plate supplies. This meter records the actual time-on-air of the transmitter. I took a look at the readings for the past few months. My figures showed that there was more time on the meter than a quick inspection tallied on the log. But, I merely made a mental note to keep better records and put down the discrepancy as lousy bookkeeping.

I continued to wonder about those "goodies" as Brad called them and regretted the fact that they could not be counted in any awards or total. I did not even recall hearing such stuff as MEØUW, although there had been some really screwy calls issued in the past few years. Yet– there was *something* that bugged me about those QSLs!

A few evenings later I got out those strange cards and spread them on the table. Nugget was sitting on the end of the operating table looking out the window. I noticed that he kept slyly turning his head to watch me lay down the QSLs. When I put down the pretty one from YL1KIT I saw a furry paw reach out and give the card a pat! The paw drew back lightning-quick as the cat obviously did not wish me to see his actions. He sat there– silently and with not a whisker twitching. Then he resumed looking out the window.

Suddenly, as it so often does, the band came alive and KA1TS came blasting in, the cans screeching out his call. The KA signed and I looked at Nugget. His eyes were open in a wicked fashion. His right front paw stiffened and reached out toward the key. The cat started to tap on the Navy knob! Shocked speechless and motionless, I just sat there. Nugget saw me stare at him and drew back his paw and began a careful inspection of the sheathed claws, completely indifferent to my bewildered glance as he took refuge in a routine cat-type operation– paw inspection.

I have been a ham for over forty years, boy and man, but what followed is the weirdest thing I ever had happen to me!

Startled, I said out loud, "I'll be–". A furry paw shot out and I heard the key click out "BK BK" as the cat manipulated the key.

Incredible thoughts raced through my brain. Could my pet understand what I say? To test him, I spoke out firmly. "Look here, Nugget! Can you understand my speech? Can you send Morse code?"

He did not hesitate. The cat's paw acted and the key clicked "C". I gasped and muttered, half to myself, "Oh, a traffic man!"

"Not me, OM" came the clicked reply, "I just know all the tricks." The cat looked smugly at me as I sat there bewildered and amazed.

As I sat there looking at my unbelievable pet he jumped from the table to the work bench where there was a transistor code practice set. He stood over it staring, until I reached for it and picked up the set and put it on the operating table. Nugget immediately moved close to the practice key and sat there– waiting.

I saif out loud, "Let's get this matter straightened out." I paused and continued. "So you understand when I speak to you?"

Then came the answer that almost rocked me from my chair. "Sure, OM. All us cats dig English." The tiny loud speaker on the code practice set rang out this unexpected reply as the cat skillfully manipulated the key.

"How long have you understood human talk?", I quickly queried the cat.

"That is the second most important thing we learn. First comes eating, and then comes language." The cat seemed very sure of himself as he pounded out the code in a precise fashion.

"Why don't you ever speak to us?" I inquired.

"We do, but you dumb clods can't hear us cats talking!" The golden-furred face bore a smirking look. I could see I was being forced into a corner, so I tried another angle of attack.

"Look here, Old Cat. What about your operating on code? Isn't that *unusual*?"

'Well, OM. I *am* getting through to you on CW. Right?"

"How about the rest of you cats?", I asked my pet.

Nugget drew himself up proudly and replied in well-sent Morse: "That is a different story. Very few cats can pound brass. Most cats are 'fone men'. If you don't believe it, just listen in on any phone band and hear all the cat-calling and squeals, especially on AM fone."

I muttered to myself, "He's got something there!" But, being undaunted, I plunged in even deeper as I queried, "How did you learn the code?"

"It was this way. You always leave the receiver going full blast. Right? And, you know how some signals just seem to drift back and forth across the dial?" I knew just what he meant.

The cat went on. "That is the way I started. I lay here trying to get some rest after a hard night out, but that CW kept whistling in my ears. I'd hear a station call. Then another would answer him. I got so I could read letters. Then came whole calls that I could catch. Finally, I got so I could copy whole QSOs." The cat stopped and looked at me, but I said nothing so he went back to his brass pounding.

"Soon as I got 'over the hump' it was easy, OM. Later I found out about tuning and happened to tune in a code practice session. Then, I listened whenever I could hear W1AW and W6OWP. That is when some lid did not smother their code practice transmissions with QRM. Say? OM! Do you think I could get a Code Proficiency Certificate from ARRL?" The golden-haired puss looked up at me, with great pride in his huge yellow eyes.

"Come now! You don't think I believe that you have qualified for a CPC." I did not give him a chance to reply but pushed right on into my next question. "How did you learn to send?"

Back came a snappy answer in the form of another question. My cat was up to people-type tricks! "How did *you* learn?", he sent.

Without thinking, I replied. "Why, all us Young Squirts learned by tapping out code on a desk or table with our fingers." I looked at Nugget who did not seem impressed, so I added. "We even had QSOs that way."

"Why not?", snapped the cat. "I've tried lots of times to raise you, but OM, you sure are slow on the up beat!" Then the cat really set me back on my heels as he told me his

theory of learning the code. "Once my subconscious mind had mastered the code it was easy for it to transfer this ability to digital functions and what happened? I could pound brass as well as receive." The cat's face was full of smugness as he sat back and waited for my reply.

"Was it you, Old Cat, who ran down the batteries in the code practice set?" I asked in an accusing tone.

"Sure, I had trouble operating that little switch so I just left it on all the time."

"So– you learned to copy and to send CW. Now tell me, how did you work the rig and the receiver? What about the foot switch, Old Cat, how did you use that?"

I looked so scornfully at my cat that he lowered his head but tapped out, "Ebony was my second operator and foot-switch man."

I looked around for the black pussy cat, Ebony, but he was not in the shack. The golden-furred paw went on and continued to send flawless code to tell me this amazing story. "I tried to get Ebony to learn the code so he could operate as well as I. But he would not practice and he thought it was not worth the effort. Oh, he learned to read and to send calls, and he could even hold a simple QSO. But, let's face it. He was never a hep cat on CW."

"Tell me, Nugget. How did you work the rig? The foot switch? That takes coordination!"

"OM, I sit in front of the receiver, like this." The big cat moved over in front of the HRO and put one paw on the huge dial. This dial turned easily due to its well-worn smoothness through years of use. The cat moved the dial with practiced ease. He then returned to the practice set and sent, "That's the way I tune the receiver. Then I hit the key at just the right instant."

"The foot switch? What about that?" I implored. "How did Ebony know when to press the switch?"

"We cats have our own *private* means of communication and it sure beats electronics. Not a tube or even a transistor." The cat seemed to sneer as he manipulated the key with precisely-formed characters.

I had no reply as that comment only substantiated what I had long believed about animal communication.

The cat went on sending. "I tell Ebony when to press the foot switch and he knows from my sign off when to release it."

I had about reached the limit of my credulity and was about to blow my stack but I took one more chance and ordered– "OK! Old Cat, let me see an actual demonstration."

Nugget shrugged a whisker and replied on the key, "Why waste the juice? You know the band is dead."

I was in no mood to argue with a cat. "Never mind that. I want to see you operate. Dead band or live band. Hop to it!"

'OK, OM. If you insist. QRX one." Nugget jumped from the table and darted out the cat's door to the outside. In a few minutes he was back close-herding a reluctant, paw-dragging Ebony. The black cat crouched on the floor beneath the operating bench, obviously still half asleep. Ebony looked up at me with a mournful, resigned look. This being drafted to help operate was nothing new to him and not very pleasant either, his sad eyes implied.

Nugget said something in cat talk to his assistant operator which, naturally, I could not hear. Ebony moved over and crouched near the foot switch. There he sat, Sphinx-fashion, paw on board, waiting a command.

"Let's see you cats raise someone. Any one!" I demanded.

Nugget smirked at me, whiskers twitching, but moved to the HRO and sat up on his hind quarters. With infinite patience and considerable finesse, he slowly rolled the dial by applying paw pressure to one side. I heard a loud signal calling CQ. The paw stopped and the CQ ended. It was K9DOG. The signal was loud and clear. The cat ignored it and continued tuning over the band. Puzzled, I inquired, "Why not him?"

Nugget jumped to the practice set and replied, "OM, we cats *do* have our pride." Then he strutted back to the HRO. Tuning around he brought in another CQ and the letters of the call were C A T. The cat-operator slipped a paw and nudged the *rf* gain control. The signal rose to a more readable level and the cans rattled out the code. Nugget raised up, pressed the spotting

Micro-Switch on the vfo and, with his other front paw, carefully tuned the variable oscillator to zero beat. Then he relaxed, paw on key until the stated signed. It was K8CAT.

My two pets, by their own communication method undetectable by humans, were in contact and ready to go into action. The black puss was almost asleep, and relaxed, but at just the proper instant down went the black paw, the foot switch closed, relays clattered and W5CA was on the air! I watched speechless with amazement!

Nugget tapped out a sharp 3 x 3 call and sent AR. His co-operator under the table raised his paw, the relays snapped over into "receive" position and I heard K8CAT come back with a good report to which he added, "You must be a visitor at W5CA. That fist does not have Mid's Lake Erie swing."

I could stand this incredible sequence of events no longer so I reached for the key, just beating Nugget to the Navy knob by a whisker's width. I sent,"*This* is Mid. The other operator was my cat." I stood by. There was a long pause—

"Did you say your c,a,t?" inquired the distant 8.

"Yes, OM." I repeated, "my cat." I looked over at Nugget who was now engaged in a microscropic examination of his left paw. He showed only indifference on his golden face. I looked down at the black cat, Ebony. He was still crouched at the foot-switch with a paw in the "ready" position.

K8CAT was still unconvinced as he asked, "You mean a feline animal? A pussy cat?"

This time Nugget's paw beat my hand to the key and he replied, "Sure—a cat. I am twelve years old, name is Nugget. I have a golden coat and a long fluffy tail. BK."

There was a vast quiet on the frequency. Then came a stuttering sound of characters incoherently formed. Finally the dots and dashes dribbled off into gibberish. Then—more silence and lots of it!

Nugget looked at me and I am sure he shrugged his whiskers. His look said-well, that guy just could not take it. The cat seemed unmoved by the distant amateur's confusion.

I reached for the log book to record the ill-fated QSO with K8CAT. That action brought back a flood of memories and raised some pointed questions in my mind. What about those uncheckable QSLs? Such an event could have brought in QSLs from those "unknowns".

Then the shack roof fell in on me! MEØUW—MØUSE and YLIKIT! Could it be that my cat operators were *that* selective?

The golden cat moved over to the practice key and resumed our cross-band QSO in his excellently-sent code. "Only the good DX. Ebony worked some of the locals. He does not dig DX like I do. Besides, he has a lousy fist-I mean *paw*. I don't let him operate often."

I glanced at Ebony but he appeared to be sound asleep. Perhaps he was and had not heard Nugget's slanderous remark, or perhaps the code was just a bit too fast for him.

"Perhaps, OC," I continued, "you would care to tell me how you learned about DX and what *is* choice DX?" My voice was more respectful as the awsome facts began to sink in.

"I read QST's 'HOW'S DX'. You always leave the magazine open at that page, OM" sent my intelligent pet.

"Now, Nugget!" I said with triumph in my voice. "I've got you! It takes a magnifying glass to read that fine print in QST."

"BK—" sent the cat, "you know that us cats are very proud of our keen eyesight. Why, OM, I can even read the addresses listed in the *call book*!" Nugget was really smirking now.

That did it! I realized that this discussion, while enlightening, was not placing human beings in a favorable light. I leaned down and picked up the sleep-limp Ebony. I placed him by the practice key and said, "Let's hear your fist, Ebony!"

Nugget must have said something to Ebony. The little black cat put out a stiff paw and slowly tapped out in uneven characters—"Ur s igshere 5 59Q T HTijer as Ne w Mexic o handlehereEbony how cpyb k toyou." Ebony relaxed in a heap beside the key.

Nugget shot out a paw and sent briskly, "You see what I, mean, OM He has listened to and worked too many Novices." The

golden-furred cat seemed almost ashamed of his companion's inept operating skill. "But", the sending continued, "he is really a sharp foot-switch man."

I was chagrined at all these proceedings but yet I was determined to add some reproachment for the cats'actions. "Look here, you furry scoundrels. What about FCC regulations regarding 'unauthorized operations'? What about Rule 12.1?"

Nugget broke me on the practice key and replied. "You mean where it defines an 'amateur' as a person interested in radio technique? The FCC cannot bother us cats. Cats are not persons!"

I could think of no fitting response to that obvious truth so I pressed on to another point. "How come you never filled in the log or answere any of those QSLs?" My questions were almost a sneer.

Nugget's reply was the coup de grace as he snapped back. "Who ever heard of a cat who could *write*?"

... W7ZC

Save That Manual

Every ham who has been actively associated with the hobby for any appreciable length of time has around the shack a multitude of rigs, rotors, and test equipment which requires occasional maintenance of one type or another. When the equipment was new, the last thing on the owner's mind was a future need to refer to the instruction and/or service manual. All too often it is tossed into a corner and forgotten. Comes the day service is necessary or a sale imminent and the manual is not to be found.

One excellent way to keep this valuable information at your fingertips is to place all such data in a three-ring notebook (three-ring because smaller manuals will still be held by two of the rings). The dime-store variety binder will do nicely. While there, also buy a set of inexpensive dividers, and label each with a type of equipment. Having separate sections for the various types of equipment will speed your progress when you need a particular manual.

A second method, which I find to have advantages, is to buy a separate folder for each piece of equipment. The cardboard type with three double metal tabs is available at your local stationery store in various colors. In this shack red indicates transmitters, black is test equipment, grey is antennas, rotors, and other outside hardware. A typed, gummed label on the cover indicates the exact contents. These folders may be neatly kept on a bookshelf where they will be easy to find. The uniform size and the color coding make the shack take on an air of neatness which could well become contagious. **William P. Turner, WAØABI**

Solution to puzzle on page 114.

1 A	M	A	2 T	E	U	3 R	■	4 C	I	R	5 C	U	I	6 T
N	■	■	I	■	■	7 A	S	H	■	■	A	■	■	W
T	■	8 B	E	9 L	■	T	■	A	■	10 A	M	11 F	■	E
12 E	M	U	■	13 E	X	C	I	T	E	R	■	14 E	Y	E
N	■	15 M	16 E	G	■	H	■	T	■	17 E	18 R	G	■	T
N	■	■	M	■	■	19 E	V	E	■	■	H	■	■	E
20 A	21 M	B	I	E	22 N	T	■	23 R	24 F	P	O	W	25 E	R
■	A	■	T	■	U	■	■	■	R	■	N	■	O	■
26 A	C	E	T	A	T	27 E	■	28 M	I	D	B	A	N	29 D
D	■	■	E	■	■	30 N	E	E	■	■	I	■	■	O
A	■	31 I	R	32 A	■	C	■	G	■	33 N	C	34 O	■	U
35 P	R	O	■	36 S	T	O	R	A	G	E	■	37 R	U	B
T	■	38 N	39 A	P	■	D	■	B	■	40 T	41 A	B	■	L
E	■	■	R	■	■	42 E	R	A	■	■	N	■	■	E
43 R	E	A	C	T	O	R	■	44 R	E	A	D	O	U	T

Knight V-107 VFO for Six and Two Meters

Ralph Steinberg K6GKX
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Long Beach, CA 90803

Just finished the Knight-kit V-107 VFO and it took me one hour to do it. Would you believe two hours? Honestly it took me three hours by my stop watch to assemble, wire and calibrate this VFO. Time was not essential, but I was anxious to see how long it would take to complete the kit and have it operating.

Assembling the Knight-kit V-107 VFO is so simple that any previous experience is not necessary. The instructions in the manual make every step of construction easy to follow. The text and pictures show exactly where each wire or component fits in. Yes, the wires are even cut to length, stripped and ready for soldering. If you are not an expert on soldering now, there are some excellent lessons in the construction manual which will make you one.

The V-107 VFO is usually sold as an accessory for the TR-106 and TR-108 Knight-kit Transceivers but it can be used with any 2 or 6 meter transceiver or transmitter. It uses the Clapp oscillator (sometimes known as Colpitts) for maximum stability and has a high L/C ratio in the tank circuit, resulting in less drift. The output of the VFO has a minimum of 20 volts RMS which is enough to drive most any transmitter for the 2 and 6 meter bands. A high-gain pentode, 12BK6, is used for the oscillator tube and a voltage regulator tube, OA2, is used to stabilize the voltage on the screen of the 12DK6.

Calibrating the V-107 is no problem if the step-by-step instructions are followed in the construction manual. You will find it just takes three important adjustments, L-1, L-2 and C-2, to calibrate the VFO for either 2 or 6 meters. With these adjustments finished you are ready to work anybody on these bands and be on frequency of any station. It might be suggested that these calibration adjustments be made after a thirty-minute warm up to make sure they are correct.

Power requirements are 200 volts DC at 30 ma and 12.6 volts AC at 150 ma for the 12DK6 oscillator tube and can be supplied from the TR-106 or TR-108 Knight-kit Transceivers. Should the VFO be purchased separately, power can be taken from the transmitter or transceiver of your choice. An outboard power supply with the same voltages will do as well.

When the V-107 VFO was finished, "on the air" workouts were done to check drift, temperature and mechanical stability. On drift it was minor and in line with the specifications of the manufacturer, Allied Radio Corporation. For temperature, it was cool as cucumber and this is due to power levels kept at a minimum allowing for very little heat dissipation. The mechanical stability can be said that the V-107 is rugged and designed like the well known expression . . . "just like a battleship."

Two different 2 meter transmitters were used for checks on this VFO and in each case there was plenty of drive and it operated the "rigs" satisfactorily. Much of this was due to keeping the output cable of the VFO short, as recommended in the construction manual.

For the ham that has just a few crystals to operate on the 2 or 6 meter band, the Knight-kit V-107 VFO just cannot be beat at the price of $24.95.

. . . K6GKX

Technical Specifications

Frequency coverage: 8.333 to 8.666 mhz for 6M; 8.000 to 8.222 mhz for 2M.
Frequency stability: +/-500 cycles per hour after 30 minutes.
RF output: 20 volts rms minimum into 47K/30 pf.
Power requirements: 200 vdc @ 30 ma; 12.6 vac @ 0.15 amp.
Tube compliment: 12DK6 oscillator; OA2 voltage regulator.
Cabinet size: 5½" x 4-5/16" x 6½".

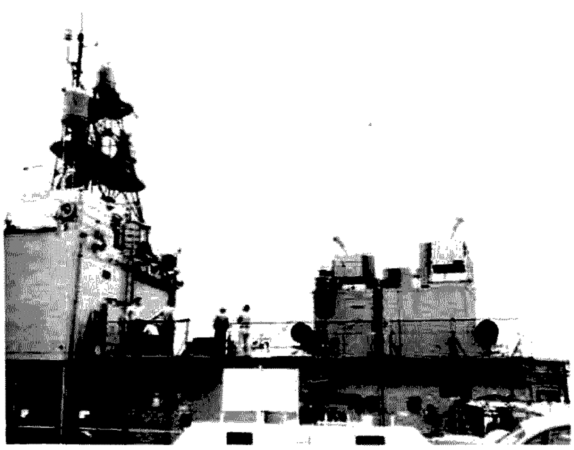
Careers in the FAA

Sam Kelly W6JTT
12811 Owen St.
Garden Grove, CA 92641

Looking for a way to combine a career in electronics with adventure and above average earnings? Want exciting work on a tropical island, a tracking ship on the high seas or in Europe? If so, you should look into the opportunities in field service.

Field service (also called field engineering) provides technical support and operating personnel for equipment after it has left the home plant. As you can guess, the U. S. Government is the biggest customer for electronics equipment and field services. The government needs technical help to keep the vast amounts of electronic equipment associated with our space programs and weapon systems operating.

Besides private industry, many branches of the government operate their own field service organizations. An example is the Federal Aviation Agency (FAA). The FAA maintains an excellent field service organization that performs such widely diversified tasks as making radar surveys to determine the best locations for long range radar stations to the installation and check out of the latest digital computers. Many other government agencies operate similar services.



IEC Field Service Engineers prepare a portable telemetry system for a polaris tracking mission at sea.

Field service organizations have openings for job skills ranging from engineers to electronic assemblers. In general most hams would be interested in becoming engineers or technicians.

This is one of the few fields where a man can still work into an engineering job title without a degree in engineering. However, this is rapidly changing. If you are planning on becoming a field service engineer you should obtain a Bachelor of Science degree from a recognized engineering school. Concentration should be on applied engineering courses rather than the more theoretical subjects. A Master's degree is just as desirable here as in other engineering jobs. It is especially important if you later decide to change to "in-plant" work.

Requirements for field service technicians vary between companies. In general, the higher quality organizations require two years of junior college electronics, a technical school certificate, or advanced military electronics training.

Completion of military service is advisable for all field service positions as this provides invaluable experience in working with military personnel, and most field service organizations deal directly with the military. In addition, most companies pay a premium to men who have received training in armed services schools on equipment related to their products.

The current demand is greatest for personnel with backgrounds in telemetry systems and metric radar, particularly those with experience in the uhf range. This is due to the big change in telemetry frequencies from the old 215 – 265 mhz band to the 1435 – 1540 mhz and 2200 – 2300 mhz bands. Other critical areas are radar repair and digital data systems.

Field service work may be any where in the world. As an example IEC, the prime

FAA Field Service Technicians aligning UHF receiver banks. In addition to on-the-job training, the FAA provides excellent classroom instruction at the FAA Academy.

contractor for POLARIS/POSEIDON test instrumentation has operations in Spain, England, Guam and at shipyards in the U. S. In addition, they supply personnel and equipment for special operations on ships throughout the world. Men in organizations of this type learn to move fast. Frequently they have to be at a new location thousands of miles away overnight. This type of work demands the development of tremendous versatility. One job may be trouble shooting the latest S-band telemetry system on a tracking ship, the next may be installing missile test equipment on a nuclear submarine.

A well-known field service organization is Philco-Ford's Educational and Technical Service Division. This organization grew out of the famous "Tech-Rep" group. They currently have operations throughout the world, from exotic pacific islands to Viet Nam. The services range from operating missile test ranges to running mess halls!

How do you find out about job openings in field service? Probably your best source of information is the Sunday edition of the Los Angeles Times. Other sources are the trade journals such as the IEEE Spectrum and the Engineering Opportunities magazine. Remember, most big electronic companies have field service divisions. A letter to their personnel offices will usually bring you a list of their openings.

There is a wide range in the quality of field service organizations. Some are little better than hiring halls for semi-skilled technical personnel. Others provide men capable of doing advanced engineering. It pays to carefully investigate before accepting employment. The company's name isn't always indicative of the quality of their field service branch. Arrange to talk with personnel working in the organization, and visit one of their facilities, if at all possible. In general, the smaller the company the greater the variety of work available – and the greater the individual's responsibility.

There are many "pros and cons" to field service jobs. In the asset column you have travel, adventure, the challenge of working on a wide variety of state of the art electronic equipment, working with interesting people and high pay. On the liability side you have extensive travel, complicating your family life, high living costs, wierd climactic conditions, and high pressure work. If you are looking for adventure and are single, the liabilities are quickly overcome! The pay, which is above average, helps, and in most instances there is an additional tax free per diem allowance of from $12 to $25 per day.

. . . W6JTT

continued from page 7
agers, I frequently find that they have no desire at all to make money. This may be apathy or it may be a reaction to parents that idolized money. It is frustrating though to have what seems to me to be a really simple way to almost unfailingly make a fortune and find that no one is listening.

How long do you think it will really be until we have space stations parked in our skies making wires across the earth a thing of the past? Telephones in the shirt pocket. FM radio and TV from space. Instant accounting down to the smallest store in the country. Letters and photo copies anywhere instantly. The hardware and software for this boom will be manufactured by new companies, and hams will play an important part. The youngsters that recognize this now and get ready for it will be the winners. Ham radio is an excellent start. And courses such as advertised by Cleveland Institute can't but help.

It might be inspirational for the younger members of your radio club if you invited some of the older members who have used their background in ham radio and parlayed it into success to give a talk. If you don't have any real success stories in your club, look around your local area and you'll find them.

Much of the hard work they will tell you about and which is a key ingredient of their success, is education. It may not be in college, but it could be self-education, reading, mail study courses, and brain-picking every expert you can corner.

Before you sit down to write a heated letter hating me for discussing such outrageous ideas, please take some time and marshal your facts. I will bow to documentation and facts, not to steam and emotion based upon disturbed beliefs. As always, I will most enthusiastically publish further thoughts along this line, pro or con.

Reactionaries

The next time you run into someone on the air or at a club meeting that gets mad when you try and discuss methods of improving the ARRL, just remember that reaction is a very normal human condition. The human body tends to reject the transplant of foreign tissue on it. This certainly is rather parallel to the way in which any mind tends to reject any idea which seems unfamiliar or which threatens an existing system. The intrusive forces are sloughed off or ignored, just as an aging lion tamer resists the decision of a circus manager to buy more lions, or just as an executive tends to resist the decision to computerize a business, forcing him to grow into new skills.

Ideas must be presented slowly and cautiously, always equating them to previously understood concepts, if they are to be accepted. It is all too easy to leap into a conversation, as I frequently do, presenting the solutions to problems rather than the groundwork for understanding the problems, which will in turn lead to the obviousness of the solutions. Don't do as I do, do as I say.

Marathon Nets

Bud Massa W5VSR has been registering some legitimate complaints about the overbearing arrogance of some net control operators. His letters are inflammatory, so I'll digest the complaint for you. The problem is that some net managers have gotten the idea somewhere that the net frequency is sacrosanct and that everyone should move off the frequency when it comes net time. After using a certain frequency for some months or years they have developed the strong belief that this is now their frequency.

As a strong believer in the value of nets, I recognize that they serve several very useful functions. First of all, by making it convenient for a group of similarly interested operators to get together they make amateur radio more fun for all involved. I'm all for this. Secondly, by stacking a large number of stations all on one frequency with, normally, only one talking at a time, great gobs of frequencies that might otherwise be used are conserved. I'm all for that, too.

There is no question that it is a lot more difficult to run a floating net than a fixed one. When the qrm is heavy, it can be awfully hard to locate a net if it is even a khz off its regular channel. Most of the time, this really isn't true, and the gathering could easily take place plus or minus 5 khz with little difficulty.

Perhaps a little more consideration from everyone concerned will smooth over the

problem before it gets to the FCC petition stage. Net managers could make a try at starting on the net frequency and, if resistance develops, could ask the fellows using the channel to direct net call-ins up or down a few khz to a clearer channel. Four years ago I was given the stiff arm by the net control of the YLRL net and I am still resentful. Let's try real hard not to have this continue.

FCC Actions

RM-1455 is a request for the FCC to return to its previous practice of issuing requested amateur radio calls, when available, when sufficient reason exists for their issuance. It proposes that similar calls be issued to amateurs changing call areas. Thus W1XYZ could request and receive W2XYZ, if available, upon moving to the second call area.

With roughly one fifth of the amateurs moving every year, it would be nice if we could return to the old FCC custom of permitting the retention of the call suffix when changing call areas. Please drop a letter to the FCC backing this proposal so we can maintain our call letter individualities.

RM-1456 is a request for the Technician Licensees to be granted the same A-1 operating privileges as the Novice Licensees. Since the only difference between the Technician and the Novice License is the theory exam, there would seem to be as much value in the Tech having the same opportunity to learn CW by practice on the air as the Novice. Since few VHF receivers are capable of receiving CW, the Techs are robbed of the use of code. We might see many more of them going to the General Class License if they were not bottled up on voice bands.

Please write to the FCC and give them your thoughts on this matter. FCC, Washington, D.C. 20554. Only one copy is required for comments on RM's.

FCC Pronouncement

Since the fall amateur contest activity will soon be here, we believe you will be interested in a resume of a recent explanation of what the Commission considers to be an acceptable station identification, as follows:

For compliance with rule Section 97.87(a), the last transmission of the exchange of transmissions with another station must include that "other" station's call sign. For example "BK 589 CAL TU DX1DX de W6XYZ K" would be in compliance with §97.87(a). When there is a need for identification of the "other" station in an exchange for the benefit of our monitoring facilities, it is most likely to be heard if it is in the last transmission or at the end of a long single transmission.

Where the transmissions of an exchange are very brief, such as the typical contest exchange, if it is less than 30 seconds duration, the entire last transmission is considered the "end of the exchange" for the purpose of compliance with §97.87(a). Provided there is no mistaking which is the transmitting station's call sign, the call signs may be anywhere in such last transmission. While the rule no longer gives examples, continuation of the traditional practice of placing the transmitting station's call sign last or preceding it by "de" is acceptable for this purpose.

Examples of acceptable end-of-exchange transmissions of less than 30 seconds are:

"DX1DX de W6XYZ 589 CAL BK"
"DX1DX W6XYZ 589 CAL K"
"DX1DX 589 CAL de W6XYZ K"
"DX1DX 589 CAL W6XYZ K"
"589 CAL DX1DX W6XYZ K"

For telephony, the voice equivalent of the foregoing examples may be used, substituting "this is" or "from" for "de", etc.

ARRL Questionnaire

Some $37,000 has been quietly spent by the League General Manager out of a fund set aside several years ago for the international protection of amateur radio. Are the members of the League entitled to any accounting of this substantial expenditure? Usually reliable sources tell us that a good part of these funds have been used for pleasure junkets for top HQ officials. Who is responsible for accounting for these funds? Has there been any evaluation of the international status of amateur radio or of the effect that the spending of this $37,000 has had? When something like this is kept a tight secret it is only natural to worry that there may be a cover-up of skullduggery.

The stockholders of most corporations insist on knowing where the money goes. They demand to know the salaries of the officers and want nothing hidden from them in the published financial statements. ARRL members have, for many years, been asking for the same basic information about their club, but with no success whatever. The truly impressive salaries at HQ are highly classified and subject only to conjecture, even by staff members. If the salaries are reasonable, then why this tight secrecy? What is being hidden?

. . . Wayne

ZL to SM Moonbounce

John ZL1AZR arranged schedules with Kjell SM7BAE during early 1969, but the very short overlap of mutual moon visibility made it difficult. Times and frequencies were worked out, with 144.003 mhz being selected. The antenna would have to be pointed within $2^{\circ}$of the moon. "On our first sked on March 3rd we heard each other at a just detectable level. The next day, at 1728 GMT, call signs were partially copied and at 1746 signals peaked to 12-15 db above the noise. In the next few minutes call signs and signal reports were exchanged to comply with the accepted standards required to constitute an official contact.

"The total useful period was about eight minutes, the moon's elevation was $9^{\circ}$and we think that the extra 3-6 db ground reflection gain due to low angle radiation greatly assisted."

SM7BAE ran 1500 w to a 4CX250R and 16 ten element yagis. The receiver used a 2N4416 preamp up at the antenna. ZL1AZR ran a pair of 4-400's in Class B with about 600 watts output and eight bays of 6/6 slot fed yagis. The receiver had a preamp up at the antenna,and a bandwidth of some 200 cycles.

The signal report system used was a code containing the letters T, M and O. T means that weak signals are present. M means that partial call signs are being copied. O means that both the call signs and signal report have been copied. If almost perfect copy is possible the number "5" is used. Dots are hardest to copy, so dots are only used in the signal reports when good copy is probable. A contact may be claimed if an O level is achieved.

The distance involved was 11,370 miles, a little better than Ray VK3ATN's 10,417 miles.

John tells us, "There is no easy way with moonbounce. Anyone deciding to have a try must be prepared to stop being a communicator and become an experimenter."

The above information is from the Journal of the Aukland VHF Group, via Amateur Radio, the Journal of the Wireless Institute of Australia.

"Up with miniskirts!"

Boy Scout Jamboree-On-The-Air October 18-19

Held since 1958, the Jamboree-On-The-Air (JOTA) has become one of the most popular events on the annual scouting calendar. Like scouting itself, the JOTA has grown from what in 1958 was just an idea in the head of Les Mitchell G3BHK to an event which every year attracts some 3000 stations in over 70 countries, each with its own little group of Scouts, Cubs and Guides. Some stations have as many as 150 Scouts attending during the 48 hour event.

Apart from its main object in promoting friendship between the boys, the JOTA does have one other major aim—that of introducing boys to amateur radio. It is interesting to find that several hundred boys have obtained their own amateur licenses as a direct result of being exposed to our hobby for the first time during the JOTA. Some of them are known to have gone on and made their careers in electronics and allied fields.

On a world wide basis the JOTA is organized by the Boy Scouts World Bureau which was until early 1969 located in Ottawa, and whose permanent station VE3WSB became a most sought after station, not only during the annual week-end of the event, but also during Jamborees, Exhibitions, etc., to which it was transferred by special arrangement.

In May 1968 the World Bureau was transferred to Geneva. While awaiting the completion of their permanent home, the directors have gratefully accepted the offer of the use of 4U1ITU for the 1969 JOTA.

Thanks to the Bulletin of the Swiss Union of Short Wave Amateurs for the above.

Moving? Please Let Us Know!

Carl Drumeller W5JJ
5824 NW 58th Street
Oklahoma City, OK 73122

Scanning the Flyers

Scanning H & R's Catalog 35

Herbach and Rademan catalog volume 35, number 3 hardly can be classified as a "bargain sheet" in the usual sense of the term. It does, however, provide the widest selection of high-quality electronic and mechanical gear you can find anywhere . . . and often at much reduced prices. As customary, this catalog leans heavily toward laboratory-grade goods. Some of the items are used, but all are in top-class condition. Meter multiplying resistors, at 0.5% accuracy and standard capacitors at 0.5% accuracy are examples of components. There is page after page of General Radio, Hewlett-Packard, Tektronix, and other laboratory-type equipment. These are not cheap. For the amateur constructor, there's a 0-400 microammeter with a needle movement from right to left . . . just the item for a signal-strength meter in the plate circuit of a tube. Another choice article is a miniature 200-0-200 microampere meter, zero center, that mounts with a single ½-inch panel hole. This should be handy for a discriminator or a phase meter. The first-listed is priced at $3.00, the other at $2.00. For a permanent shop set-up you can buy (for $15.00), mounted on a black anodized aluminum panel, 2-inch Weston meters: 0-1 ma dc, 0-5 kv dc, 0-500 v dc, 0-20-100 ma dc, 0-150 v ac. If you're interested in stable frequency standards, how does this strike you? A 500 khz crystal oscillator with a two-stage harmonic amplifier for $5.00; the crystal is in an oven which requires 6.3 v at 1 a; the oscillator and its amplifier need 105 v at 10 ma.

Scanning the Radio Shack No. 189 Flyer

A new bargain flyer always makes interesting scanning. This one is no exception. Several unusual "buys" catch your eyes immediately. Like, for instance, 10-watt resistors in fractional- and low-ohm values such as are needed for power transistor emitters; these are two for 79¢. Their aluminum "mini" boxes are both inexpensive (89¢ to $1.29) and adaptable to many a hamshack project.

It seems that most projects involve transistors. And transistors often are happier if you use a heat-sink when soldering to their leads. At 99¢ for a kit of five, you can buy peace of mind inexpensively, especially when you consider that one of the five has a magnetic base that'll often provide that third hand which nature failed to provide to electronic experimenters.

Although the designers probably didn't have amateur radio in mind, the "Servo-Switch" ($14.95) can be used to good effect by many operators. It comes in two units, both of which plug into the AC power line. One unit, the receiver, sets adjacent to the device you want to turn on. The other is a transmitter that you can take into any other part of the house. If you want to watch a TV program right up to the minute you're due on a schedule, you watch it. But, about ten minutes before "air time," you snap a switch on that little hand-held transmitter . . . and on comes your rig.

The 69¢ packets of small hardware are hard to pass up. It seems that you're always short of some small item. With 28 to choose among, most of your needs can be met.

Scanning World Radio Lab's Catalog

This catalog is unique in at least one respect: It is the *only* one that starts out with amateur radio gear and then drifts into CB and audio equipment! And what a welcome relief it is.

In another matter, too, it is highly unusual. That relates to the wide variety of amateur equipment lines it lists. You might think Leo would push his own excellent line (Galaxy) to the exclusion of others. Not so. You'll find Swan, Drake, Sideband Engineers, Johnson, Ameco, Gonset, Millen,

Waters, Hallicrafters, Collins, National, Hammarlund, Sonar, and a few other but lesser-known brands given quite complete coverage. The prices are right, too. Like many other dealers, you'll find "discounts" (a very naughty word among manufacturers and many dealers) hidden under the guise of inflated "trade-in" allowances. These, of course, apply only in instances of purchases of higher-priced items. Most dealers consider themselves fortunate if they don't have to pay too much to have traded-in equipment hauled off to the city dump; so they can take this loss only when there's a considerable profit on the sale.

This catalog lists quite a number of items that you can't find easily elsewhere. Open–wire transmission lines, copperweld antenna wire, guy wire, three-gang capacitors for pi-networks, coils and switches for pi-networks, and (hold your hats!) ferrite beads! Another item seldom seen is a miniature rotary switch that has a progressive shorting feature . . . a very desirable capability in some applications. Another rare one is an adapter to mate a male uhf connector to a female Type N connector; this for just $2.95.

From the stand-point of a really complete listing of manufactured amateur transmitters, transceivers, and receivers, plus a reasonably good listing of components for amateur building projects; I conclude that the World Radio Laboratories catalog is one of the most valuable available.

Scanning the Poly Paks Flyer

Bargain hunters are getting a glassy look in their eyes . . . that new Poly Paks catalog has just too many attractive "buys" to keep track of them. You can pass over page one, but page two lists a 1.5 A, 2000 PIV diode for just $1.00; it ought to hold just about any power supply for modern transceivers. Page four shows a Fairchild 703 linear integrated amplifier for $1.59. That's hard to beat. Across on page five, you'll see a 23 V NPN transistor, rated to 400 mhz, for 2.99. At that amount, one can afford to indulge in frankly experimental "cut and try" exploration in the field of transistorized transmitters. Page six is a happy hunting round. There you'll find 15-ohm earphones at 4 for $1.00; 3000-ohm ones at 2 for $1.00. Handsome instrument knobs are 5 for $1.00 in the 2" size and 3 for $1.00 in the 3" size. These are for ¼" shafts. The back cover, really page eight, shows 2N2222 NPN transistors at 5 for $1.00. Considering that these are good for a half-watt dissipation, can stand up to 60 volts or take up to 800 ma (but not both at once), and work satisfactorily at 250 mhz; you'd be hard put to come up with a better source of oscillator, multiplier, and buffer stage transistors.

Scanning the Allied Summer Flyer

Like many flyers, this one tends more toward completed items of consumer's goods rather than components. Nevertheless, it's of interest to the avid bargain hunter. Leafing through it, the first thing to perk your interest may be the $10 price reduction of the Model A-2515 solid-state communications receiver, which makes it an even more desirable item to have around to supplement your amateur-bands-only receiver. Overleaf is an AM-FM receiver for $8.88. This triggers a thought: Why not a converter feeding into this for a nearly no-cost 50 mhz or 144 mhz FM receiver? (More on this later.)

Now for some components. Twelve heat sinks for popular-size transistors for just $1.78 looks like a real bargain. So does a transformer having 6.3-V and 65-V (center tapped) secondaries for only 98¢; this is nearly ideal for transistor experimentation. A wide range of zener dioded at two for 68¢ (1 to 2 W rating) suggests inexpensive voltage regulation for that power supply. And there's a crystal microphone for 88¢! Remember what they used to cost 30 years ago?

Let's get back to that converter-plus-FM receiver combination. This begins to look even more interesting when you read over the specifications for the $29.95 Model KG-220 receiver kit. This has all the goodies that would cost you time, effort, and money if you were to build your FM receiver from scratch. It has a ratio discriminator (none of this slope-detection makeshift), squelch, and slow-motion tuning. Its metal cabinet should provide some measure of shielding, if you were to use it as a tunable *if*. Having both

tubes and transistors, you'd have power available for either type of converter.

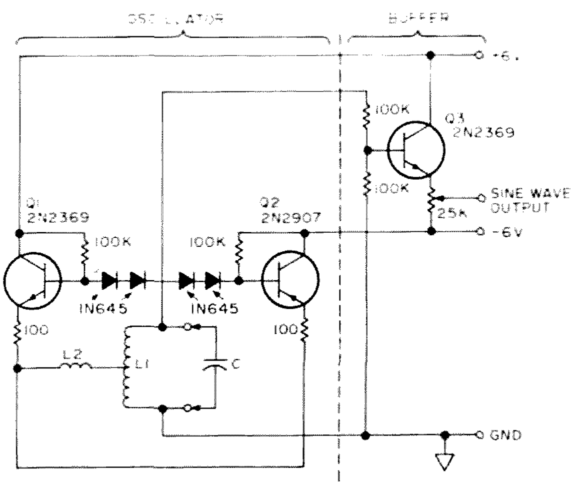
A simple crystal-controlled converter for either 50 mhz or 144 mhz should be easy to design and construct. For local signals, one dual-purpose tube would do the job. Or, if you're really ambitious, you could come up with a converter that would break the squelch on a one-microvolt signal!

Scanning the Olson #769 Catalog

Olson is a firm that issues catalogs at rather frequent intervals; therefore each edition differs but little from the previous one. Catalog #769 lists the usual lines of imports, mostly useful gadgets, but few items relating directly to amateur radio. Of course, crystal microphones at two for one dollar will attract the attention of any amateur who works phone. And if that amateur has a phone transmitter without VOX, he may be interested in spending $14.95 for a hand-held microphone with a built-in six-transistor VOX circuit. As no anti-VOX is provided, he may have to keep his receiver volume low or wear headphones to avoid chattering. Another useful item is a circuit breaker that may be used on everything from low-voltage dc to 117-volt 60-Hz ac. These may be had for 1, 5, 8 or 20 A at prices ranging from $2.99 to $3.49.

. . . W5JJ

Errata



This was left out of the article on page 88 of September. Please cut it out and stick it in.

Ralph Irace WA1GEK
Assistant Editor, 73
Peterborough, NH 03458

Youth Forum

Today's youth has been speaking out all over the world as it has never before in history. The protests are heard in colleges and even high schools. The pressure is building up and perhaps we can look forward to some explosions in amateur radio.

Youth has been getting the dirty end of the stick from the ruling cliques in many amateur radio clubs. In others, and more usually, they drop out in disgust. Bad scene either way.

The rumble of discontent has been rising steadily at ARRL conventions and the day may not be far away when something breaks. The youth are well aware of the dirty deal they have been getting from the entrenched old timers who are running the League. They've watched the ARRL Incentive Licensing scheme eat dangerously into the ranks of the youngsters and they are angry over the new two year wait for a higher class license. They've watched the FCC figures showing a catastrophic drop in newcomers to our hobby and they point an accusing finger at ARRL HQ.

The rigged ARRL Open Forums at conventions are no longer fobling the youngsters. They want answers. They want action. They want a change in the basic ARRL policies which prevent a Novice or Technician from holding office. They are bitter over the recent change in the by-laws, obviously aimed at them, where the Directors explicity prohibited anyone under 21 from running for the office.

Have you run into an SCM that refuses to appoint teenage hams to leadership posts (EC, SEC, etc.)? If you run into this, and it is not unusual, unfortunately, then get together with some friends and try and get the rascal out of office. Let him know that you care. If you round up the teenage votes you could well win, because many of the older hams are, sunk into disinterest and could care less even if the hobby continues. They may be dead from the neck up, but you aren't and you can run rings around them.

Teenage traffic nets are fun and informative. They are a step in the right direction. There are only a handful at the moment, such as the New England Teenage Net which meets daily on 3905 at 1900 EDT. The Missouri Teenage Traffic Net meets Monday through Saturdays on 3904 at 1900 CST. The Cornhuskers (Nebraska) Teenage Traffic Net gets together daily on 3982 at 1830 MST. The Tennessee Teenage AM Net works Monday, Wednesday and Fridays on 7280 at 2200 EDT. If you know of more nets please tell me about them.

We really do need a lot more teenage nets, so how about getting things started in your area and passing along the word to me? We could even use a national teenage net if some of you want to bite off a really big chunk to chew on. Sound groovy? Alright, write to me.

In the meanwhile, how about making a big try at getting some teenagers into the SCM chairs. Do you realize that not one single SCM in the entire 74 ARRL sections is a teenager? It is really about time that the teenagers got into gear. It takes only five signatures from ARRL members to run for SCM, you know. Don't let them keep you down forever . . . give them a battle this year!

. . . WA1GEK

LETTERS

Dear Wayne,

I believe your honorable draftsman made a small error in the "ultra stable power supply" diagram on page 116. The 1K resistor ought to be in the "down" lead from the +300 volts; the low voltage end of the 1K then goes to solid-state VR and to plate of V1-B.

Neil Johnson W2OLU
74 Pine Tree Lane
Tappan, NY 10983

Dear Wayne,

"The Genesis of Radio Reception" by W1USM in Aug. 73 was most interesting, as it contained the technical information on early radio experiments that history books always leave out.

Bill Hood's excellently written article, however, makes no mention of the American, Nathan Stubblefield, who is certainly not an unknown. On the contrary, Stubblefield must be rated as the most inventive and advanced of the radio pioneers. In 1892, he demonstrated his apparatus which could send and receive voices and music at distances of at least a mile over land or sea. He even built small, portable rigs that equalled or bettered the performance of today's economic marvel of Japanese technology—the three transistor walkie talkie!

This, mind you, was happening several years before Branly learned how to make iron filings fidget in his "coherer," many years before the electron tube or the crystal diode, and quite a while before the eighteen year old Marconi would become famous with his crude spark-gaps and "conveyor-belt" receivers.

I would certainly like to see some information on the circuits and equipment used by Nathan Stubblefield, the apparently forgotten inventor of modern radio communication.

J. R. Johnson WA5RON
5111 Boca Raton
Dallas, TX 75229

Dear Wayne,

After reading your recent editorial about the ARRL proposing to give away ten meters to the CB gang I went on the air and tried to get some letters going to the Directors. Out of 25 contacts only three said that they would write. The others said it sure was terrible, c u agn sn sk.

Russell Platt WA9ZVD
126 Laura Lane
Thornton, IL 60476

Dear Wayne,

In reference to my letter published in the May issue, I would like to thank the many hams for their letters and cards. Everyone received was in accord with my remarks on the incentive licensing issue that was forced on us by the ARRL and the FCC.

As I continue to observe the results of this insidious incentive licensing rule I see how it will have continuing cumulative psychological effects that will be detrimental.

Most hams that do get the Advanced and Extra Class find a coolness towards them when they begin to mention it over the air. The majority seem to feel—well so what, now stay in your exclusive part of the band and don't bother us, there is enough qrm around without your type. So I suggest to the amateurs that wish to waste their time and money taking the Advanced and Extra, keep quiet about it. Just remember the ham on the other end may feel as I do that you have let your fellow hams down—they are sitting this one out because they feel it is a stupid, senseless, undemocratic and unfair ruling that will, if given enough time and is ignored by the majority of sensible thinking hams,, be rescinded as it was before for what it is—useless and a waste of our band allotment.

I suggest hams contemplating Advanced and Extra give the above serious consideration. I would rather keep all my friends than be thought of as a superior big brain and resented.

I sometimes wonder if this was not instigated for the express purpose of reducing the ranks of the amateurs in the United States. Could this be the amateur pill?

One of the truths of warfare is to divide and conquer. They have certainly divided the amateurs, scared off many a newcomer and disgusted many an old timer into hanging up his key.

George Brook Taylor W4PZS
1133 S. W. Fifth Place
Fort Lauderdale, FL 33312

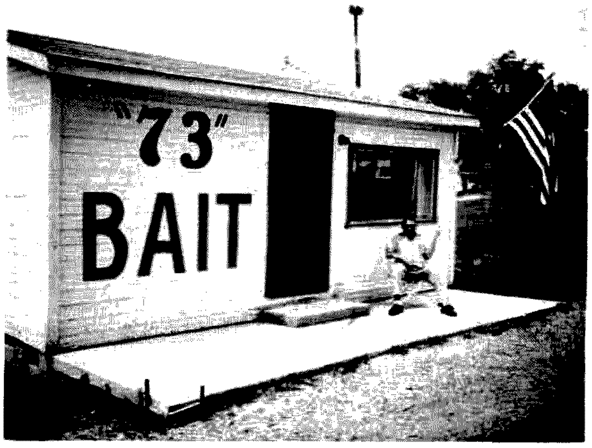
Wayne,

This is just a letter from a member of the younger generation who feels that while everyone's telling everyone else to run a ham radio, he might as well throw in his two bits.

The credit for my original interest in amateur radio goes to Walker Thompkins K6ATX. As a twelve year old in need of a book report I read his adventure story, "SOS at Midnight" and got so excited about it that I read his other books, 'CQ Ghost Ship" and "DX Means Danger,' of my own free will. After following the books' hero, Tommy Rockford (16 year old electronics genius, football player, detective, and superhero—K6ATX), through many exciting adventures, I had learned a lot about ham radio and I was eager to become a ham. As I've always thought that I was a normal twelve year old, I will surmise that other twelve year olds can be equally impressed with Tommy Rockford and ham radio.

Attention hams and ham clubs! Be certain that K6ATX's books or books like them are in every grade school library. But—make sure that in every book is an insert giving names, addresses, and telephone numbers of amateurs in the area who are willing to help people get started, or willing to just show a wide-eyed youngster a ham shack. I could have become a ham five years ago when I read "SOS at Midnight," but I didn't make myself known, and local hams didn't make themselves known.

Duane McGuire
933 Crescent St.
Raymond, WA 98577



Dear Wayne,

This bait store is located about a mile north of Hillsboro, Ohio on state route 73, hence the name "73 Bait." Mr. D. L. Simpkins is the owner and has given permission for you to publish the picture if desired.

We could have "doctored" it up a bit with someone posing with a 75S3 on the end of a line, but thought that this was sufficient to get the idea across.

Paul Terrell, MD W8NTZ
1440 N. High St.
Hillsboro, OH 45133

Dear Sirs:

I noticed the two following errors in the printing of my article "4 Thirty Twoer" in the July issue of 73. In figure 3, the cathode pins (pins 6) of both V_1 and V_2 should be shown grounded. Also, the value (not too important, however) of C7 should be .001, and C_2 and C_3 should have a maximum value of 20 pf. While this may seem trivial, I did receive a long distance phone call from another ham who wanted to know the capacitor's values. His keen interest in beginning the project overwhelmed me, since I hadn't even received my copy of 73 through the mail yet!

Larry Jack WA3AQS/KL7GLK
3 Barry Ave.
Annapolis, MD 21403

Dear Wayne,

Just happened to run across the article ("Kluge Tube") in the March, 1969, issue. As I (along with a few other hams) was deeply involved in the development and mass production of this tube during WW2, perhaps I can shed some light on its characteristics and purpose.

The VT-158 was the brain-child of Dr. (Major at that time) Harold Zahl of the Ft. Monmouth Signal Corps Laboratory. It is essentially a 304TL with increased filament power and temperature (for increased emission) and with rather limited life by ordinary standards.

Although the internal tank circuits may look like they are intended for a frequency of 1000mhz, the operating frequency was 600mhz. The difference being due, of course, to the internal capacitances. Mu was, like the 304TL, in the neighborhood of ten. Power output of the VT-158 was about 200 KW peak, at an input of approximately 1 megawatt, peak. The efficiency wasn't too good, but considering high-power triodes at this frequency, it wasn't too bad, either. Operation was at a plate voltage of approximately 20kv with 1 or 2 microsecond pulses at a repetition rate of 240 pulses per second. The pulse modulator was a rotary spark-gap network-discharge device attached to the shaft of the gasoline-engine driven generator which provided power for the whole system. The audio output from this spark-gap outfit was deafening, and security of the installation must have been negligible.

The radar system employing this tube was, so we were told, part of the D-Day invasion apparatus. Although I was never privileged to see the complete installation, it was reported to have been housed in a tent with center-pole mounted parabola. Its mission was to detect low-flying and dive bombers. As I recall, the prime contractor for the system was W9ZN's Zenith Radio.

R. L. Norton, W6CEM
722 East Gutierrez St., P. O. Box 1469
Santa Barbara, California 93102

Gentlemen:

Recently I've run into some "old timers" who would like to get back on the air. One of the things that seems to give them pause is the new terminology which pervades the ham magazines. Modern electronic magazines are written only for the "in-crowd" who have mastered the new abbreviations that these magazines have foisted upon them. Perhaps I can be of assistance—here is a list of these modern abbreviations, along with the translation of what they *really* mean:

pf . . . not a sneaker—usually, "mickey mice"
µf . . . too small to measure, forget it
cap . . . pronounced "condenser"
hz . . . pronounced "cycles," with one exception—some modernists claim that "hz" is pronounced "Hertz," but who ever heard of a "cycles antenna"?
khz . . . pronounced "Kilocycles"
ghz . . . this horrible-looking glitch is the exception—say "kay-em-cee"
ERP . . . your *rf* ammeter reading times at least 50.
PI . . . a magic number equal to (a) exactly 3 or, (b) exactly the square root of 10 depending upon the equation in which it's used
SWR
VSWR . . . swer or vizwar—this you ignore in quoting ERP—ignore it
FCC . . . means the same old thing—this you can't ignore!

Doug McGarrett WA2SAY
28 Holbrook Road
Centereach, L. I., NY 11720

ITEMS OF TRIVIA

Page 123-124 of July issue appears to have diagrams reversed—right? When I took my 1st class telephone test almost fifteen years ago, one of the questions involved an FM discriminator and all I could remember was where it was grounded. Still remembering only that, the diagram totally confused me until the text tended to clear it up.

I'm sure glad you stay away from space-filling chatter ("Operating News") as one of the other magazines uses, such as W6XXX bought a new call book, or WA3XXX put some new finals in his linear. Seriously, the Pickering Radio people have an excellent product in their code practice tape, and after seven weeks of intensive work, I passed

the FCC test. The Pickering tapes should receive enthusiastic endorsement. (WA6CPP passed his advanced exam . . .)

Paul Schuett WA6CPP
14472 Davis Road
Lodi, CA 95240

Dear Wayne,

I've been reading your *73 Magazine* editorials; and I like your frankness and open-minded views, so I'm writing to express mine.

Just a little background so we talk the same language. I've been interested in ham radio since I bought my first receiver in 1933 for $33.00. Twenty-seven years later I sold it for $30.00 to a young fellow trying to get his ticket, and it worked like new.

Over the past years, I've belonged to several radio clubs and have helped many a ham get his ticket and a TVI free rig on the air. Why not, ham radio *has been* and still *should be* the best hobby, and it is a good investment for our country. You'll notice I said has been and should be.

I consider the years up until the early 1960's the Golden Years of ham radio. Those were the days of home brew equipment and comradeship. Fifty or seventy-five miles was not even considered when it came to helping a fellow ham de-bug his rig. The accomplishment and the feeling of pride one received when he heard "old Virg's" rig on the air made ham radio have a meaning. To sit up half the night and work on a piece of equipment while ragchewing with a mobile or two that were following the local H. S. or college team bus home through a storm was just part of being a good ham. Integrity, responsibility, and justifiable pride were a part of the teaching to be a good ham that was given each new ham. He knew if he did not measure up he would be dropped.

In the early 60's several things began that have changed the conditions and attitude of ham radio. The two major ones were the introduction and acceptance of CB radio and SSB ham radio. Progress is inevitable and new things will come out. To classify or not, CB or SSB as good or bad is not really the issue, as both have their good and bad points. To point out the real issues, I will give an example that happened to me. Many (too many) similar examples have happened since; and I got to thinking.

After successfully building my own, mobile and home, AM & FM rigs and could use the home rig as a relay station, I figured I'd try SSB. Some surplus xtals and equipment and many moons later I had an excellent workable rig with a grounded grid (4-1625's parallel on 75 mtrs.) on the air, TR switch and all. My first contact (outside local) gave me a good report at first but when we exchanged Q-th equipment types he never came back. Later (several days) I heard him ragchewing with another station, and he said he was not about to talk to anyone who didn't have top line (no commercial names) equipment. If the sigs weren't coming in S-9+ he wouldn't even answer them. As I said, this happened so many times to me that I began to say I had "top line" equipment. Then I really started thinking. Is this really ham radio?

Where had my integrity and pride of accomplishment gone? This is not the ham radio for me. So projecting a long look far into the future I could see only one workable plan to keep ham radio alive and with something to look forward to. So I began to express myself at clubs and on the air. Several old timers were with me, but that was the support I got.

About this time CB radio was blossoming and (even through 1968 this is still happening) young high schoolers and the college set found they could get on the air for $40 to $100 mobile or fixed station and no code, not even an exam for a license; and they could yak away to anyone in the country. The cost of SSB equipment for a mobile rig is from $300 to $500 and if they get that kind of money they invest it in wheels, a bomb or some sort, and then maybe, I say maybe, a CB rig. It's easier, costs less, and they have less restrictions. They can even get a 65 watt transmitter for around $50; so who needs ham radio? Facing this reality, how does one go about getting them interested in being a true ham.

One young (H. S.) fellow purchased a SSB transceiver and before he had it paid for it was obsolete (pwr. & selectivity wise) and his trade-in would be a lot less than he had a right to expect so, he operated as is. Try selling ham radio to some of these youngsters and they may go so far as to invest in a novice Tx & Rx and for a short time they enjoy it; then they find the temptations and the going tough. They have invested in low power AM equipment and have a hard time selling it. They key up and get a 2 or 3 word per min. contact and then the return op comes back with 10 or 15 w. p. m. and they get discouraged and start tuning up the bands; and soon they find the CBers are having a ball. Knowing most of them, he finds he can get a xtal and pur his rig on with the rest of them. Another ham lost.

It's not hard to see today's problems, or mess, or hangups, or what ever you call them, they are real and definitely with us. So once again I'll propose what I feel is a solution to our problems. I know I'll get a lot of static but then I'm used to it by now.

The main thing is to think for the good of ham radio and not for the good of oneself.

With SSB and RTTY proven to be fast and superior to CW why not leave CW out of the picture (except as a rider). All hams should by exam prove they know theory and good operational practices. All hams should be general class and use any band *but be restricted to 250 watts input* or *pep power*. (No more spiraling of power and price out of the reach of the junior and the overseas ops.) After 3 years of a general ticket and, the building of a complex workable piece of equipment plus an exam one could get an advanced ticket that would entitle him to put a kw on the air on any band.

Area clubs who have at least one advanced ticket holder *as an officer* would and should be permitted to give the exams. They would also have the responsibility of updating the hams in their area and of policing (if I may use the word) the same. For the ham to again be looked upon as anything but a nuisance he must accept the responsibility and let those who can perform be the liaison between the FCC and the ham. The local newspapers are supposed to be for the good of the people they serve, so, why not have local committees or representatives to approach the local hams and CBers who are directly violating the rules and privileges of the area and print their name, address, and call in the local paper for a week or so. If they don't conform then let the FCC designate the action to be taken.

Active clubs with dues and a place to use

modern equipment are a must as technology has advanced beyond the stage of each ham owning his own test equipment or of (in many cases) the ham even repairing his own equipment. If we don't pull together, we will be (as we are now) pulled apart.

As the first part of this letter explained, hams had a sense of togetherness that comes by doing things together, especially *working together*. We can no longer push the "on" switch of a high priced piece of equipment and be just appliance operators. If all we put into ham radio is money, I don't think we can expect much out. I was always taught the things worthwhile in life came from the heart and only the heart. All else just comes and goes.

So what say, fellows, lets put a little heart into ham radio and once again make it a worthwhile thing.

Wayne, I know that you and the rest of the staff will kick this around. Hop in, the band is open.

William A. Gardner W8EAU
5704 Decker Road
North Olmstead, OH 44070

Dear Sir:

Why doesn't your magazine run a series of articles on computer and binary logic as applied in Integrated Circuits. There are very few hams that can boast even the slightest familiarity with computer logic and I. C.'s. It would be nice to have a series of educational articles of the same quality as the "Getting Your Advanced Class License" in the past and now the "Getting Your Extra Class License." Thank you. I got my Advanced License thanks to your study course.

John C. Koning WB6VQE
4680 Crestview Drive
Norco, CA 91760

Sounds like a loser to me; any other votes on this? . . . ed.

Dear Wayne,

Glad to report the acquisition of the "EXTRA" ticket recently!

Biggest factor towards getting it was the great articles on obtaining the "big" ticket. They are written so the "self-taught guy" can grasp it—no technical terms, (or at least very few) very explanatory, and really "step by step.' Other magazines are great if you're in electronics, or have an E. E. degree, but as for me—I needed some "plain ol language" descriptions!

I found 'em in the articles and must say "thanks a lot" to the staff's effort.

R. J. Renart WB2AUF
117-09 9 Ave.
College Point, L. I., NY 11356

Dear Wayne,

In August issue, page 98, on output section, on leads going to the meter, a diode was left out (any small diode) for the rf output meter.

Thought I'd bring this to your attention before someone else did!

Bill Eslick, KØVQY
2607 E. 13th
Wichita, KA 67214

Dear Wayne,

During the past many years I have enjoyed amateur radio to its fullest degree. I have met some of the finest persons in amateur radio—and a few of the others. The spirit of maxim and others has carried amateur radio for decades. Today we need

a regeneration and real vital vitamin shots to maintain the privilege of amateur radio operation throughout the world.

The value of your efforts in publishing the magazine "73" is of tremendous value in preserving amateur radio as a hobby and as a public service. Many of us are grateful to you and to your staff for a job well done–but one that must continue.

John Tracy, W1GH
49 Broadway
Taunton, MA 02780

73 Editor,

I wish to express my thanks and congratulations on such a fine Advanced study course. I at first tried to learn from another well known publication, which need not be mentioned, and did nothing but memorize the answers as you said would and did happen. I am now using your Extra study, but because of the asinine 2 year wait for so called experience is keeping me back another year. Anyway thanks again for such an outstanding study. You should publish the courses under a different cover. I am sure you would have a great success with it.

Robert McGwier, Jr. WB4HJN
P. O. Box 565
Grove Hill, AL 36451

Good idea . . .ed.

Dear Editors:

Congratulations on your decision to cover allied fields with separate publications. While there are a great many hams who use CB radio (to good advantage), and many who follow the SWbroadcasts, they would do better advised to subscribe to magazines in their special interest. I do not wish to hunt through SWL or CB news to get at the Ham articles. And those with one of the other special interests should not be so burdened.

I recently checked an issue of QST and found about one third of it of interest to me. There are a great many Hams who are interested in contest news, organizational matters and other items which do not appeal to me. I do think QST does a fine job of covering this wide area. They have, however, fallen victim to a common failing of such publications (yours excepted). The people who write about articles they would like to see, but never bother to write that letter. Since the desired articles are usually advanced engineering, the Editors get the erroneous impression that their readers all want it. They forget that they must attract more readers, and they necessarily will come from those just starting.

Your study courses have been by far the best "Self Help" courses I have seen. With the traditional Q & A approach, there is too much tendency on the part of the student to try to memorize, rather than fully understand. There will always be a demand for the "quick and easy" memory course. From this group come our appliance operators, although many do go on to learn, and build.

Lester Ulch WB4HPB
1248 Haven Dr.
Birmingham, AL 35214

Dear Mr. Green,

Having been a charter member of your institute of amateur radio, and followed with enthusiasm the meteoric rise of 73 from its inception, this letter is addressed to you because it is felt that it

from the all-new, still unpublished "FM Repeater Directory," which is updated continuously and published quarterly in FM Journal.

Ken Sessions K6MVH
Editor, FM Journal

Dear Wayne,

Yes, quite a few of us are out here want to be able to use more, not less, frequencies. Opening 3650-3700? Now that would be incentive and would give us all a lift. I know that my operating has dropped off, way off, since last November. I find myself squashed toward the high end of the band, hearing how great it is back on the low end where I operated for the past 19 years. Yes, open something new. It certainly would cut down the QRM. And what about this VHF beacon for W1AW? What good is that going to do me? We sure do need something to spark up amateur radio, but I don't think the punishment we have been getting is the answer.

. . . . John W4AEG

Tell Our Advertisers You Saw It in 73

"If your nose runs and your feet smell, you're built upside down."

will, at least, receive some kind of consideration.

The subject: the QRM problem and crowding on our phone bands. It is time we press for remedial action. Incentive licensing certainly did nothing for this problem. At the crux of the matter there seems to be a glaring inequity in the frequency allocation that confines the U. S. amateur to a portion of the phone band, while foreign stations have full freedom of the range, so to speak.

Late callbook figures show the U. S. amateur total to be near 290,000. While foreign registrations, not including Russians, are near 137,000. If we are the greater in number, and confined to the area of the North American continent geographically, why should we be penalized for our numbers? Why should special portions of the phone bands be pre-empted for foreign use?

If you tune across the American portion of our phone bands on most any weekend, you'll find something that pretty well borders on bedlam. While tuning the foreign portion of the band, you'll find vast empty spaces there.

At the time these frequency allocations were made for our phone bands, our numbers were not such as to create any problem. Today, even with our sophisticated equipment, the frequencies available are not adequate for the prevailing demands.

For a long time that has been a rather taboo subject; however, it's time to open up Pandora's box and let the thing out for an airing.

We'll never get our share unless we're in there fighting for it. It's time now to pick up the cudgel, pen and microphone to join in a combined assault on an unfair, outmoded agreement's bailiwick.

W. A. Hanks WØKJ
Tebbetts, MO 65080

Dear Wayne,

Congratulations on a beautiful issue (August 1969). I particularly enjoyed your FM articles; the timeliness of 73 in covering the "in" aspects of our hobby never ceases to amaze me. You people always seem to be "right on top of it."

Referring for a moment to the article, "FM–Fun Maker": Lest 65,000 anxious amateurs run out quick and buy crystals and FM units based on the author's stated popular frequencies, I think it advisable to contradict one small point. The author says:

National repeater frequencies are 52.80 in, 52.72 out for six meters and 146.34 in, 146.76 out for two meters.

Prospective FM operators should be advised that in the United States and Canada there are 106 repeaters whose output is on 146.94 mhz. There are only 29 repeaters in these areas with output on 146.76. For my money, 146.94 mhz could hardly be considered anything other than THE national repeater output frequency. Also, I know of only two six-meter repeaters in the entire country with an output of 52.72, and one of them is keyed from two meters. But there are 18 with an output of 52.525 mhz.

Like many other FM'ers, the author of the above-referenced article obviously does not like repeater outputs on national simplex channels. But he can hardly change the facts by ignoring them.

As a miscellaneous tidbit of nonessential information, there are 234 open-access repeaters in the U. S. and Canada. Nearly 200 of them are on two meters. All information given in this letter is

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Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order. Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February. Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads. We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue. We cannot check into each advertiser, so Caveat Emptor . . .

FOR SALE: Old 73's complete sets: '64, '65, '67; nearly complete: '61, '63, '66, '68. Make offers. Paul Capitolo, W6RQG, 1735 LeRoy Ave., Berkeley, CA 94709

3 PLASTIC HOLDERS will frame and protect 60 cards, $1—or 10 holders $3. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, Tennessee 37066.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

"TOWER HEADQUARTERS!" 11 Brands! Heights aluminum 35% off! Strato Crank-ups-low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog-20¢ postage. Brownville Sales Co. Stanley, Wisconsin 54768.

SELL: COLLINS KWS-1, Ser. 896, $640; 75A4, Ser. 5763, $420—or both for $1025. I will ship. Lew Hindert, Rt. 4, Box 290, New Braunfels, Texas 78130.

ON AIR NOW: Complete SSB xmitter—Apache plus SSB adaptor plus mike. Mint cond. All new tubes. $150. J. F. Weatherly K1ZYQ, 473 Auburn, Newton, MA.

JOB WANTED. 15 years experience writing and teaching, 12 years writing in space program. Have first telegraph and phone licenses. Now in New England, but can relocate. Anyone need a good experienced writer? Box O-1, c/o 73, Peterborough, NH 03458.

CHRISTIAN Ham Fellowship now organized for Christian hams to have fellowship, to do tract work among hams. Christian Hamm Callbook $1 donation. Christian Ham Fellowship, Box 218, Holland, Michigan 49423.

SWAP MEASUREMENTS Model 59 GDO, excellent with manual for Freq. meter TS-323 with data 20-480 mhz. Gordon W2MPT, 25 Norma Ave., Lincroft, NJ 07738.

SASE/QUARTER coin bring GE-QSLs P24-7-"73." W2RUT, Box 275, Fair Haven, NY 13064.

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Latching Relay - Potter & Brumfield KB. 3PDT. 115 v. 60 start, 6 v 60 stop. The 2 relays can be separated, making a DPDT relay with 115 v. coil, & a SPDT with 6 v. coil. 5 amp contacts. $1.25 each, 6 for $6.00.
POWER TRANSFORMER, 275 v. no ct, 150 ma., 12 v. @ 2 amps. 115 v. 60 pri. 2 3/4" x 4" x 3½" h. Shpg. wt. 7 lbs. $1.75 each, 4 for $6.00.
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.5 mf 400 v. oil-filled capacitors, rectangular case, mil. spec. $1.00 per dozen.
Loading capacitor, 5-sections, 400 pf. per section, 3/8" shaft. Will load full power into 50 ohms. $2.00 each. Adapter to ¼" shaft. 25¢. Shpg. wt. 4 lbs.
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Hammarlund HQ-145X receiver w/spkr	$160.00

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* JUST BOUGHT OUT ORIGINAL CASE FOR CB RADIO. Includes mtg bracket for mobile use & slide-in chassis. Holes pre-punched for power transistor & power cord. May be used for mobile power supplies, P.A. system or speaker box or many other uses. Size - 3½" H X 7" W X 8½" D. Weight 3 lbs. Original cost $9.95. Our price $1.95

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Send 25¢ for Catalog 69-2

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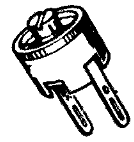
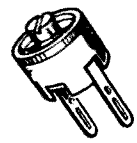
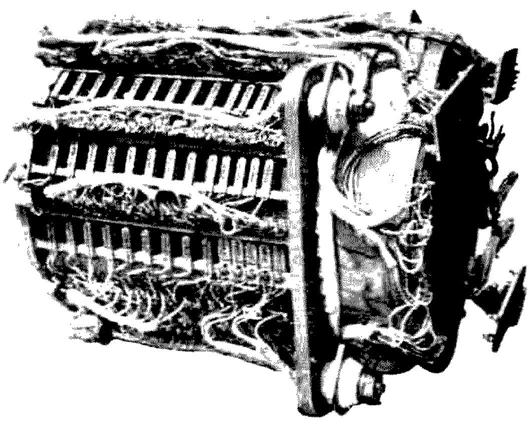




Miniature ceramic variable trimmer capacitor. Piston type tuning, size .375 diam, .275 deep. Printed circuit mount. Amateur net on this is $1.68 each. Our price only 25¢ each or 24 for $5.00. All are brand new. State size, may be assorted if you wish.

#N300 2.5-11 pf
#NPO 5.5-18 pf
#N650 9-35 pf

$6,400.00 MEMORY DRUM



Military surplus made by HUGHES for the AF. Condition appears excellent due to being enclosed in air tight case with terminations on plug connections. 134 read/write heads, 12 heads phase adjustable timing. Integral drive motor 115 volts 400 cycle.

Shipping wt. 39 lbs. . . . .#DRUM $100.00

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711	Dual Comp Amp	2.00

JOHN MESHNA JR.

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MANUALS–TS-323/UR, TS-173/UR, BC-638A, R-274/FRR, TS-186D/UP, SSB-100, LM, $5.00 each. Hundreds of others. List 20¢. S. Consalvo W3IHD, 4905 Roanne Drive, Washington, DC 20021.

TEXOMA HAMARAMA! The annual Texoma Hamarama will by held again Nov 15-16-17 at the beautiful Lake Texoma State Lodge. Plan a pleasant weekend for all. Bring the family. Mail registration fee of $2 per person to: Texoma Hamarama, PO Box 246, Kingston, OK 73439.

GREENE . . center dipole insulator with . . or . . without balun . . see September 73, page 41.

QSLS???? Largest variety samples 25¢. Sackers, W8DED, Holland, Michigan 49423.

WANTED MODEL 28KSR in good operating condition for $250.00. K. Schwieker K4KQR, 1124 Opelika Road, Auburn, AL 36830.

HEATHKIT SB-110 and Power Supply HP-23–Like New–$270.00. Charles Kehler, 1067 Western Ave., Green Bay, WI 54303.

SSTV MONITOR, 12 transistors, 5 tubes, 3RP7A CRT, Bud Portacab cabinet, tuning indicator, $190 plus shipping costs, Cohen W4UMF, 6631 Wakefield Dr., Alexandria, VA 22307.

COLLINS 75A4, Serial 2530. Excellent condition. Best offer over $300.00. Paul Delaney WB6BOQ, 1328 Calle Pimiento, Thousand Oaks, CA 91360.

FOR SALE: HT-37-HT33A, 2000 watts, PEP. Original owner. Good condition. $250.00. Pickup only. Fred Fetherolf, phone 614-332-3421, Laurelville, OH 43135.

ROCHESTER, N. Y. is again Hamfest, VHF meet and flea market headquarters for largest event in northeast, May 16, 1970. Write WNY Hamfest, Box 1388, Rochester, NY 14603.

VHF ROUNDUP Syracuse vhf roundup Oct. 11, 1969, Three Rivers Inn, Rte 57, 10 miles north Syracuse. Tickets, W2RHQ, 902 First North St., Syracuse, NY 13208.

TELETYPE PICTURES FOR SALE. 50 pics for $1.00. Perforated and audio tapes available. Write for prices specifying speed and tracks. Pictures to be included in second volume solicited. W9DGV, 2210 30th St., Rock Island, IL 61201.

WARREN COUNTY N. J. W2JT/2, October 18-19, 3555, 7055, 14055, 21055, 28055, 3855, 7255, 14255, 21355, 28555. QSL to W2 bureau.

HILLSBOROUGH AMATEUR RADIO SOCIETY, INC., (HARS) Annual Tampa, Florida Hamfest, Sunday, October 12, 1969, Lowry Park, Sligh Ave. & North Blvd. Free Parking–Many Prizes.

SELL: ART-13 Transmitter with maintenance manual, connectors, spare 813, 837, and 811's; $40. RME 435A Receiver with book and some spare tubes; $60. PCA-2 Panadaptor, 455 khz, with book, needs work; $5. You pay shipping. K9KRW, Box 436, Highland Park, IL 60035.

WORLD'S LARGEST INDEPENDENT HAM MAGAZINE

AMATEUR RADIO
73

November 1969
75¢

6M XSTR Conv.

FM FM FM

RF Bridge

Mods - SBE - Heath - Swan

6M SSB Xcvr

Solid State 432'er

IF Notch Filter

Extra Class Course

Voltage SEXtupler

Color SSTV

73 MAGAZINE

PETERBOROUGH, NEW HAMPSHIRE 03458

73 Magazine #110, November 1969

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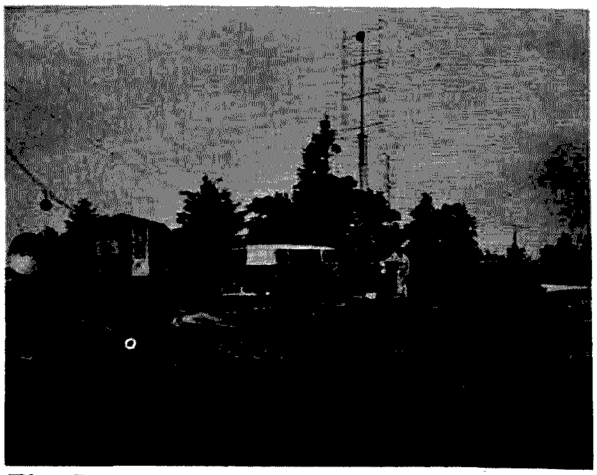
...de W2NSD/1

Wayne Green



The Cover

As I believe I have mentioned in the past, We are always on the lookout for an interesting cover illustration, whether it be a good color photo, a drawing, a painting, or whatever. The September VHF contest brought the old W1MHL group to the top of Pack Monadnock in New Hampshire using the call K1DC/1 and Roger Block, our Art Director, braved the swinging arrays with his sketchpad with the result you see on our cover.

Activity was down a bit this year, but still they did well on all VHF bands, running a small dish on 1296, 196 elements on 432, 32 elements on 220, 32 elements on 144, and a six element yagi plus a 16 element colinear on 6 meters. They all had a lot of fun, and that is the important part of it.

Advanced Class License Exams

Late in September I received a call from a distraught amateur who had just finished a commercial study course for the Advanced Class exam. He thought he was prepared, then he found that the new exams dwell heavily on transistors and sideband! He flunked, as did nine of the eleven that were there with him. He was bewildered and frustrated. His course and the text he used had failed him.

The 73 Advanced Class Study Course book ($3) seems to be the *only* study book on the market that covers the questions being used on the present day Advanced Class exams. Be prepared not to see one single tube on the new exams. Be prepared to draw transistor schematics for the Hartley, etc.

Let me say again that I think it is one hell of a note when amateurs who have been licensed and active for many years must go down to an FCC office and take a tough exam like this in order to continue to use the frequencies they have been using all these years. It is all the worse when the exam is so completely different from the older tests that it results in a high percentage of failures. Don't forget to let your QST director know what you think of this, pro or con.

November QST Board Meeting

QST is upset over the reaction to their Incentive Licensing rules and has called a meeting of the Directors for early November to see what can be done to keep the situation from deteriorating further. The FCC schedule, you remember, calls for the second and final re-arrangement of our bands to take place on November 22nd. Presumably then, QST expects the FCC to withhold its decision until it hears from the QST Board.

If all goes according to the original FCC timetable, we will see the Extra Class Only CW bands expand to cover 3500-355-, 7000-7050, 14000-14050, and 21.000-21.050. These are, needless to say, by far the best DX frequencies on these bands and their removal from the Advanced and General Class licenses will just about eliminate any further pursuit of DX as a hobby for all but a very small handful of amateurs in the U. S.

How about the phone bands? According to the schedule the Extras will have exclusive use (including CW too, apparently) of 3800-3825 and 21250-21275 khz. The Advanced will be able to use 3825-3900, 7200-7250, 14200-14275, and 21275-21350. Generals and Conditionals will be all stuffed into 3900-4000, 7250-7300, 14275-14350, and 21350-21450. That will be quite a stuffing job. You think you've had QRM before? Add to the General those Extras and Advanced that are obstinate enough to want to talk with their old friends and refuse to sit out there all alone in the big wide and frequently empty new bands.

Please pardon me if I don't even try and discuss the ridiculous mess on six meters. This makes little sense to anyone and I hate to dignify the allocations by even mentioning them.

If anyone is in favor of the second stage band

continued on page 126

Leaky Lines

An editorial in a recent issue of QST requests us to express our ideas, pro or con, to the Directors, concerning the first year of Incentive Licensing. We have been asked to put in our two cents worth, at long last. Why? There are good reasons for this sudden display of unaccustomed solicitude for our opinions.

Newington is finally commencing to realize the full implications of the coming implementation of the second phase of the restructuring program. If this goes through this November, as originally projected, thousands of hams, already disenchanted with the League, will surely drop from the rolls completely. We have already lost members in droves, are still losing them to this day, and will probably continue to lose them in the future, so long as the League persists in its refusal to admit that the original promotion of Incentive Licensing was, if not an outright mistake, at least an ill-timed miscalculation.

There can be no doubt that ARRL understood that most hams would object to the whole idea. That is why there were so many pep talks about individual responsibility, our debt to society, public service, state of the art, and so forth. Of the docket itself, however, we heard precious little, until after it had been broached to FCC without anything approaching public discussion. Oh, to be sure, we were assured that we could express our views to the Commission. Just send in 14 (or was it 114) copies of our comments to FCC, and they would take all views into consideration before making up their minds. Sounds good, doesn't it?

Evidently the Commission received very little in the way of cogent or valid objections. Or did they? We shall never know, probably. The Commission, most probably, believed that ARRL is the spokesman for *all* hams, a fond little palliative, administered in periodic doses to all League members, in order to dull their wits to the stark reality. . .about 75% of the ham population are *not* members!

The League, smarting a bit from the stream of invective that poured in, sought ways by which its unilateral action without preliminary discussion might be justified. We were bombarded with a craftily-tailored rationale. We were reminded that our image was badly tarnished . . . needed a Simoniz job. We were told that an international frequency allocating treaty conference was in the offing, and that certain nations were out to get our bands away from us, at least in part. We were assured that the only way in which this painful exigency might be circumvented would be to upgrade our skills . . . engage in more and more public service communications activity . . . dispel the commonly held belief amongst non-hams that we are merely indulging in a meaningless pastime

(continued on page 114)

CENSUS OF AMATEUR RADIO LICENSES* in the U. S. A.

by classes, within states and call areas

Call Area	State	Novice	Technician	Conditional	General	Advanced	Extra	Club	Military	State totals	YL's (Included in state totals)
#1	Conn.	221	741	801	1,827	824	202	77	8	4,701	141
	Maine	53	115	592	388	276	72	15	7	1,518	60
	Mass.	433	3,086	626	4,324	1,832	420	114	23	10,858	405
	N.H.	73	397	204	593	253	55	23	3	1,601	77
	R.I.	39	473	114	601	223	51	23	5	1,529	57
	Vermont	38	74	236	169	102	18	10	3	650	36
		857	4,886	2,573	7,902	3,510	818	262	49	20,857	776
#2	N.J.	645	3,415	410	5,324	2,356	538	156	15	12,859	313
	N.Y.	1,395	6,027	887	9,982	3,973	893	339	46	23,542	660
		2,040	9,442	1,297	15,306	6,329	1,431	495	61	36,401	973
#3	Del.	48	104	42	296	101	24	8	2	625	15
	Md.	316	879	316	2,271	1,108	282	65	28	5,265	129
	Pa.	934	3,795	877	6,290	2,321	526	208	32	14,983	427
	D.C.	30	89	29	261	143	36	22	6	616	12
		1,328	4,867	1,264	9,118	3,673	868	303	68	21,489	583
#4	Ala.	254	654	790	1,284	480	103	22	16	3,603	127
	Fla.	432	1,684	1,900	3,803	2,173	397	100	25	10,514	385
	Ga.	202	565	869	1,436	633	133	47	17	3,902	102
	Ky.	159	439	520	796	394	75	28	9	2,420	69
	N.C.	232	599	997	1,446	662	120	45	17	4,118	140
	S.C.	89	149	985	471	235	50	16	16	2,011	53
	Tenn.	288	1,066	642	1,456	690	137	41	5	4,325	126
	Va.	274	821	872	2,225	1,101	276	57	40	5,666	121
		1,930	5,977	7,575	12,917	6,368	1,291	356	145	36,559	1,123
#5	Ark.	166	272	416	523	294	54	25	9	1,759	78
	La.	214	377	720	1,134	522	100	36	17	3,120	79
	Miss.	82	136	498	513	242	36	7	4	1,518	34
	N.M.	98	144	601	376	328	76	15	15	1,653	72
	Okla.	218	652	519	1,075	622	103	35	40	3,264	126
	Texas	814	2,478	3,193	5,118	2,624	480	146	63	14,916	634
		1,592	4,059	5,947	8,739	4,632	849	264	148	26,230	1,023
#6	Calif.	2,231	8,212	3,842	15,212	8,263	1,449	482	125	39,816	1,321
#7	Ariz.	258	631	606	1,083	633	110	35	37	3,393	150
	Idaho	84	41	481	170	176	29	10	2	993	48
	Mont.	101	49	636	149	150	48	15	7	1,155	62
	Nev.	33	89	430	165	136	21	10	9	893	47
	Oreg.	369	552	864	1,534	794	127	51	16	4,307	206
	Utah	191	237	182	495	223	40	14	11	1,393	42
	Wash.	510	1,023	1,316	2,639	1,266	235	69	22	7,080	336
	Wyo.	54	33	238	101	61	16	12	3	518	24
		1,600	2,655	4,753	6,336	3,439	626	216	107	19,732	915
#8	Mich.	812	2,796	1,066	4,195	1,618	249	128	19	10,883	360
	Ohio	1,034	5,321	669	5,956	2,341	361	203	20	15,905	547
	W. Va.	158	390	193	719	221	55	17	5	1,758	44
		2,004	8,507	1,928	10,870	4,180	665	348	44	28,546	951
#9	Ill.	1,076	3,338	1,804	5,886	2,415	392	216	22	15,149	485
	Ind.	462	1,979	563	2,391	939	166	114	7	6,621	256
	Wisc.	330	779	927	1,635	818	137	73	15	4,714	112
		1,868	6,096	3,294	9,912	4,172	695	403	44	26,484	853
#10	Colo.	257	431	666	1,222	642	124	43	15	3,400	128
	Iowa	363	565	597	1,672	737	120	57	10	4,121	138
	Kas.	303	360	972	1,118	539	127	38	27	3,484	150
	Minn.	395	517	873	1,774	815	176	60	11	4,621	126
	Mo.	422	1,038	896	2,060	979	189	73	10	5,667	205
	Nebr.	173	290	492	724	361	50	32	6	2,128	86
	N.D.	36	11	440	64	96	21	8	7	683	28
	S.D.	68	45	259	236	138	21	12	3	782	40
		2,017	3,257	5,195	8,870	4,307	828	323	89	24,886	901
Grand total, 48 states and D.C. only		17,467	57,958	37,668	105,182	48,873	9,520	3,452	880	281,000	9,419

*Reprinted with permission of Radio Amateur Callbook Magazine, from the Fall 1969 issue.

An Approach to Six-Meter SSB Transceiver

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43 Burtt Street
Lowell, Massachusetts 01851

Having spent some time getting my feet wet on six meter AM, I developed an urge to join the "sidewinders" down on the low end. According to my way of thinking, a commercial six meter SSB transceiver was out because I did not care to spend so much on one band. The transverter approach was also discarded since I did not want to disturb my low band set-up. By some stroke of luck, I was given the opportunity to acquire an NCX-3 transceiver at about a third of the cost of a well-known commercial six meter SSB transceiver. I know, an NCX-3's output is far removed from 50 mhz, but a few weeks of spare-time work changed all that. The result was a SSB transceiver with the conveniences of built-in VOX or PTT, S-Meter, AM, CW, or SSB transceive operation, and all the other goodies which characterize low band operation. Power input to the final is 200 watts pep SSB, 200 watts CW, and 100 watts AM. Frequency coverage is 49.9 to 50.4 mhz.

With some effort applied to searching in classified ads, a ham should be able to come up with one of the older models of single or tri-band transceivers for less than $150. It doesn't even have to be in working condition, which would mean a lower price. The desirability depends upon your ability with a vtvm, grid-dip meter, and soldering iron. The cost of building a unit like this from scratch would be about the same with more, much more, work involved. If the job is done carefully it will have more resale value. Most of the added parts should be available in many junk boxes since they are all standard. As much use as possible was made of the original components in the transceiver.

Looking at the block diagram, Fig. 1, the 14 mhz output from the original transmit mixer is fed to the grid of the 6KE8 mixer/oscillator where it is combined with the 36 mhz signal from the triode section. The output of the pentode section is now 50 mhz SSB which is fed to the grid of the 6GK6 driver. A broadband tank circuit is used to couple from the driver to the grids of the parallel 6JB6's. The output matching circuit for the final is a conventional pi-network utilizing the original tuning and loading capacitors and ceramic coil form. The layout of the NCX-3 final amplifier compartment was well-suited to six meter operation. Do not attempt to use a mixer/oscillator combination other than the 6KE8,

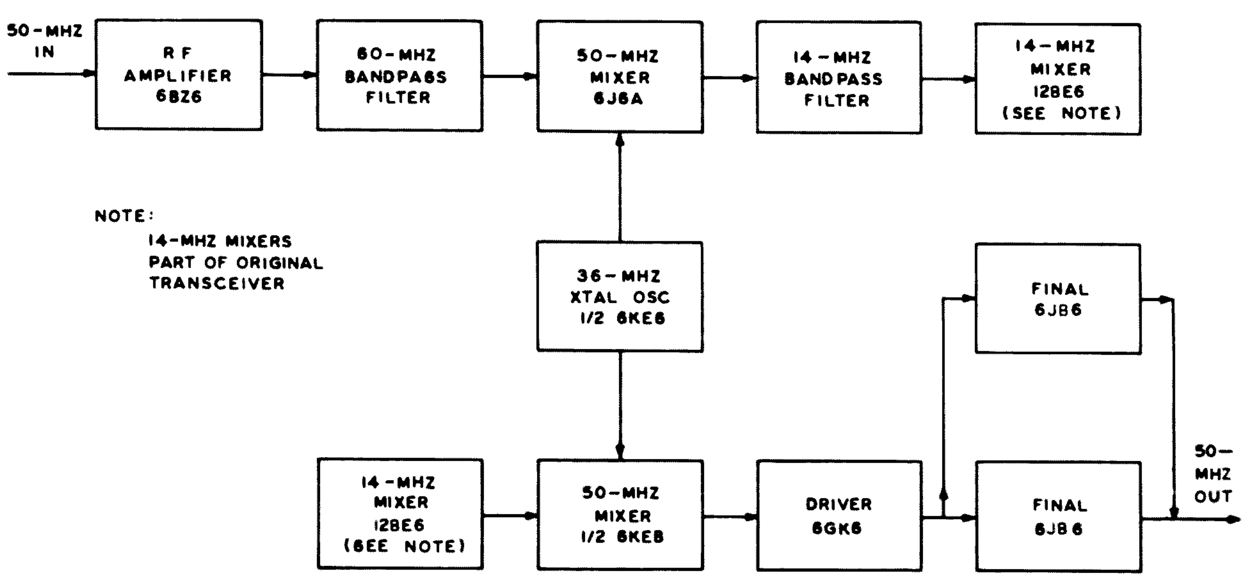
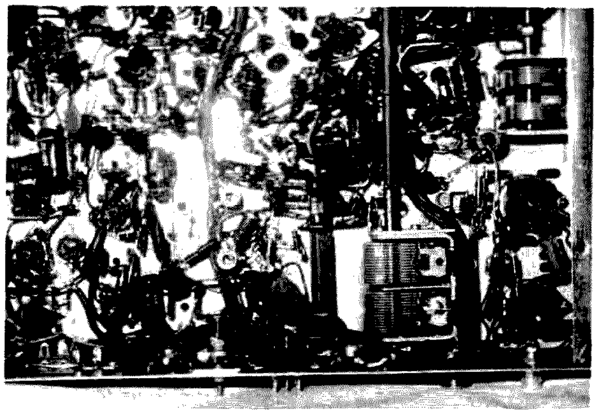


Fig. 1. Block diagram.

since this is the only tube I have found to possess enough transconductance to develop the required voltage at the grid of the driver. The mixer and driver plate coils are tapped to arrive at a better L/C ratio and improve efficiency. Tube input capacities are too large at these frequencies to permit coupling directly across a tank circuit and still maintain good voltage gain. For example, the total input capacity to the final amplifier is 60 pf. Figure the size of the tank coil to resonate with that, and you will see why an effective increase in voltage gain of about two can be realized by increasing the inductance by a factor of four and tapping half-way down.

The receiving section uses a 6BZ6 pentode in the *rf* amplifier which feeds a bandpass circuit coupled to one grid of the 6J6A mixer. The mixer output is fed through a 14 mhz bandpass filter into the grid of the original 12BE6 mixer. Someone will invariably ask why I didn't use a nuvistor front-end. There are a number of reasons why certain pentodes make better *rf* stages for six meters than nuvistors. Number one is that a pentode has an inherently higher signal-handling capability than a triode. With the amount of activity in this area, including a number of kilowatt sideband stations, the worth of a large dynamic range becomes immediately apparent, especially during band openings. I picked the 6BZ6 because it was especially designed to have low distortion characteristics. A 6EH7 frame-grid pentode would have been even better. Another reason is that agc control of a pentode is much easier than in a triode. The 6BZ6 is a semi-remote cutoff type, well suited to agc control.

The last argument for the nuvistor would be its lower noise figure. Here I contend that the noise figure of the pentode is higher; however, just how good a noise figure is needed at 50 mhz? Most authoritative sources will agree that noise figure is not of utmost importance below about 100 mhz. A good discussion of this subject is presented in Rheinfelder's book, *Design of Low-Noise Transistor Input Circuits.* If you can hear the noise coming from your antenna, a reduction in receiver noise will be of no benefit.



Bottom view of the chassis. The driver and its plate coil are in the upper right corner to the left of the exciter-type capacitor. The 6KE8 mixer is just to the left of the loading capacitor shaft (note the crystal can). The 6J6A mixer is to the left of the 6KE8. Below it are L6 , L7 and the rf stage. L5 can be seen to the left of the power plug.

The performance of this front-end indicates that atmospheric noise is a good deal larger than the *rf* stage noise (even at 3:00 in the morning). The above considerations indicate, at least to me, that at 50 mhz a pentode is still a better performer than a triode.

The modification details will vary depending on the particular unit involved but the added circuitry should remain about the same. The layout I finally decided on seemed about optimum for the NCX-3. The added tube and coil locations are shown in Fig. 3. The original 12BA6 *rf* stage and its associated circuitry was removed and in its place went the 6J6A mixer. An OA2 voltage regulator occupied a socket a couple of inches from the 12BA6 at the rear of the chassis. This was moved to a cranny next to the audio output tube and in its place went the 6BZ6. The bandpass circuits are mounted just about in between the stages. The *rf* input coil is mounted on a plate covering the hole from the accessory socket which was removed. A BNC receiver *rf* input connector is mounted next to the original uhf connector for the transmitter. I use an external antenna relay for switching between the two lines. An internal relay can be mounted under the final tune capacitor if desired. The original NCX-3 used a method similar to that found in electronic tr switches, but I found this added too much shunt capacity to the final tank coil and reduced efficiency.

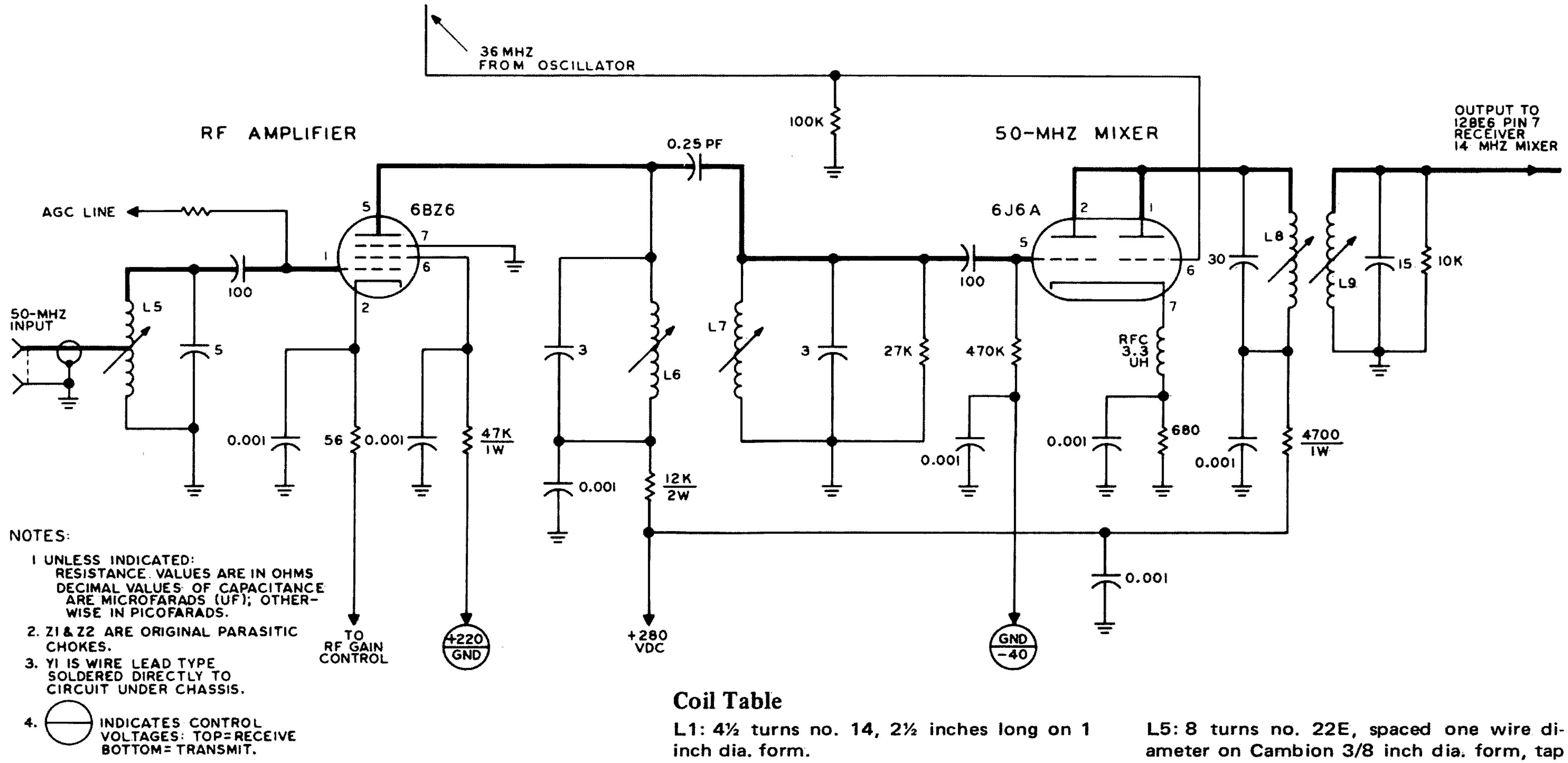
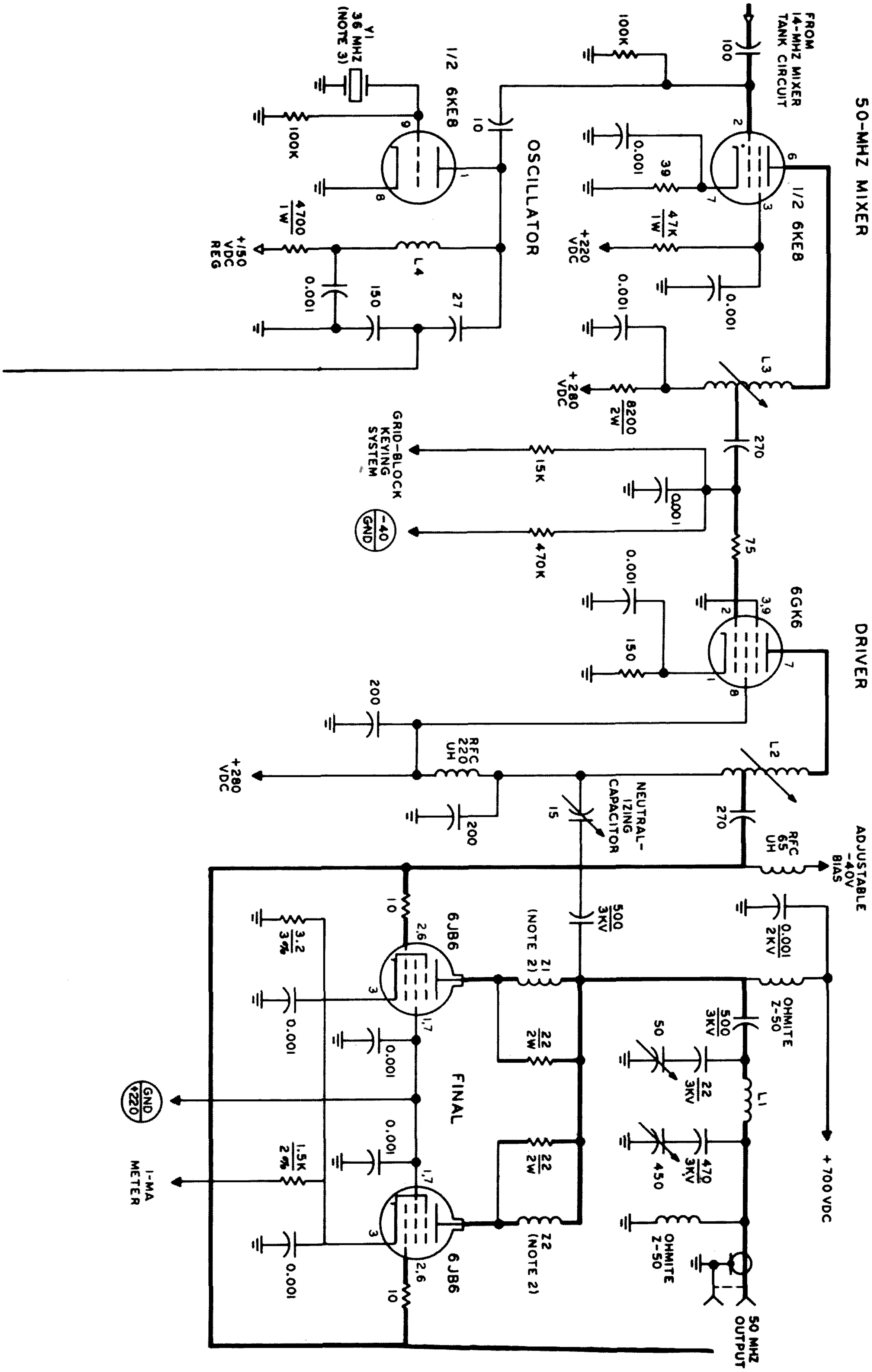


Fig. 2. Schematic diagram.

Coil Table

L1: 4½ turns no. 14, 2½ inches long on 1 inch dia. form.
L2: 8 turns no. 20, 5/8 inch long on Cambion 3/8 inch dia. form (white slug) tapped at 4 turns.
L3: 8 turns no. 26E, close-wound at top of Cambion 3/8 inch dia. form (white slug) tapped at 4 turns.
L4: 18 turns no. 26E, close-wound on ¼ inch dia. form (white slug).
L5: 8 turns no. 22E, spaced one wire diameter on Cambion 3/8 inch dia. form, tap 1½ turns from ground end.
L6, L7: 12 turns no. 28E, close-wound on ¼ inch dia. form (white slug).
L8, L9: 22 turns no. 26E, close-wound on Cambion 3/8 inch dia. form (red slug). Mount the coils in line with a center-to-center spacing of 13/16 inch.



50-MHZ MIXER
FROM 14-MHZ MIXER TANK CIRCUIT
1/2 6KE8
OSCILLATOR
Y1 36 MHZ (NOTE 3)
+150 VDC REG
+220 VDC
+280 VDC
GRID-BLOCK KEYING SYSTEM
DRIVER
6GK6
NEUTRALIZING CAPACITOR
ADJUSTABLE -40V BIAS
RFC 65 UH
RFC 220 UH
OHMITE Z-50
+700 VDC
FINAL
6JB6
Z1 (NOTE 2)
Z2 (NOTE 2)
50 MHZ OUTPUT
1-MA METER

All the original 80, 40, and 20 meter tuned circuits were removed with the exception of the 20 meter mixer plate coil and oscillator coil. The bandswitch is likewise removed. This leaves room to put the new 6GK6 driver closer to the final, and allows the 6KE8 to be put in the original driver socket. This also puts the 36 mhz crystal oscillator section of the 6KE8 in close proximity to the 6J6A. The original exciter tune capacitor is still used to tune the plate tank of the 12BE6 mixer. The final tank coil is wound on the original ceramic form and is conventional. The original final amplifier layout is quite satisfactory for six meter operation and no drastic changes were made here, other than parts values. The plate tuning and loading capacitors have their ranges decreased by the addition of series capacitors. The original .01 uf bypass capacitors were changed to .001 uf and the *rf* chokes were changed to ones more compatible with the frequency involved, an important point for anybody contemplating this type of conversion. Little things like this have a way of showing up as insufficient drive and instability if not considered in the beginning.

Upon completion of the rebuilding phase, the next step was to debug the circuits. The only problems encountered were some instability in the *rf* stage and a lack of drive for the final. The *rf* stage was stabilized by a little more isolation between plate and grid circuits, which is why the input coil is mounted on the rear wall of the chassis. This places the coil at right angles to the output coils and aids decoupling. A worthwhile idea might be the inclusion of a shield across the socket, but I did not find this necessary. A combination of the right tubes and experimentally determined bias conditions led to the correction of the drive problem. There is sufficient drive available to load the finals to about 300 mils of plate current. This gives about 200 watts input and 120 watts output into a 50 ohm load as measured on a Bird Termaline Wattmeter. The finals run class AB1 on SSB, AM, or CW. AM input is 100 watts with about 30 watts of carrier output. The tubes are overloaded under this condition, but the

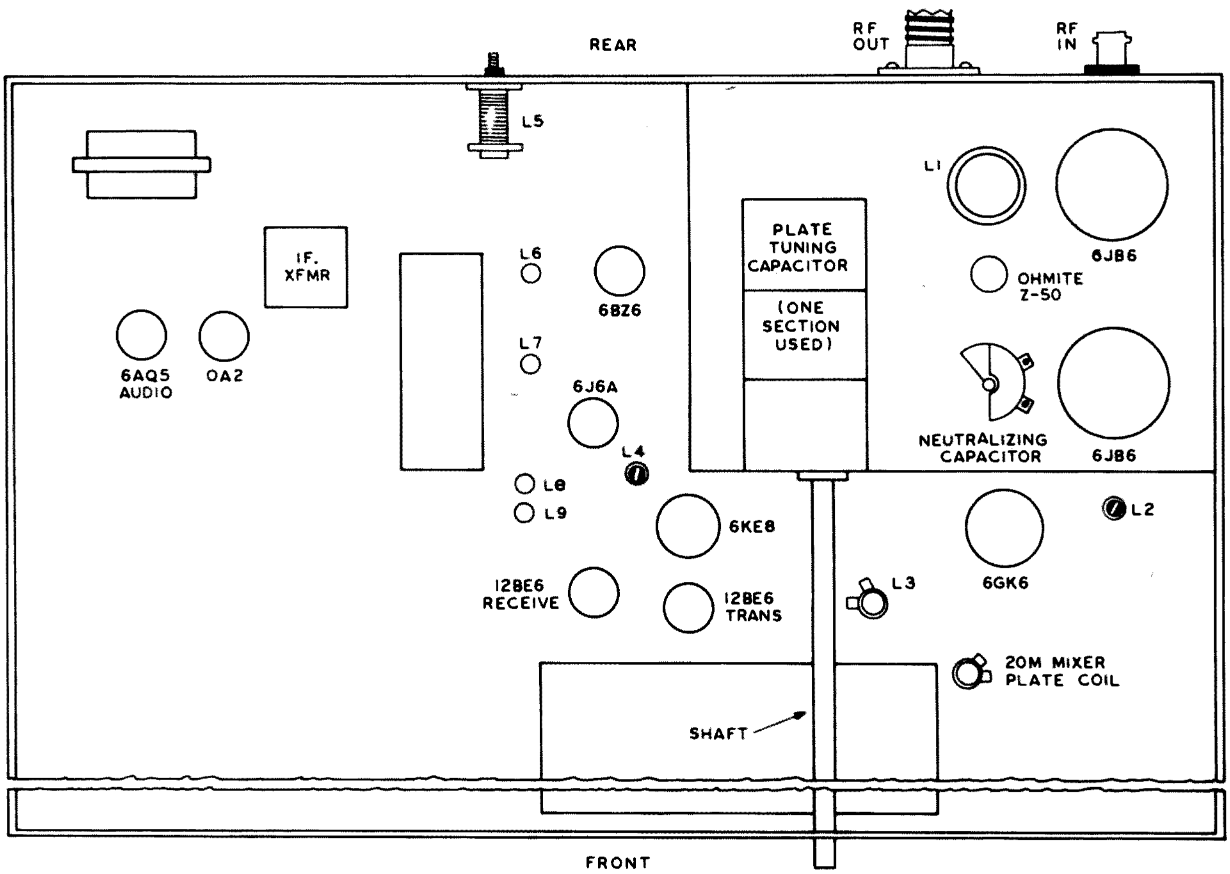
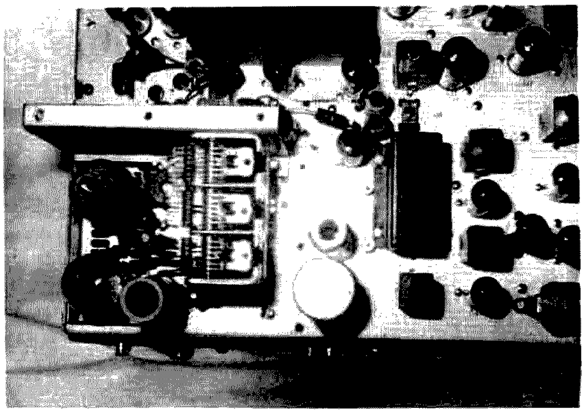


Fig. 3. Simplified drawing of the chassis top, showing the locations of the major added parts. L2, L4, L5, L6, and L7 are mounted under the chassis. L3, L8 and L9 are mounted on top.



Top view of the chassis. This photo should be compared with **Fig.3** to get an idea of the layout.

assumption involved here is that since PTT or VOX operation is involved, the carrier will be applied with modulation in which case (100% modulation) the efficiency will be about the same as with SSB. There is something to be said for these low cost TV sweep tubes in AB1 linear operation. 6146B's could have been used, but this would have required a socket change.

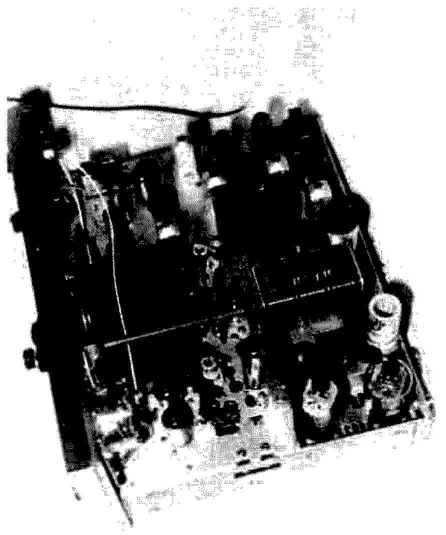
A word is in order about the efficiency of an AB1 linear. I have found that efficient operation requires enough driving voltage to swing the grid up to zero volts with the load resistance adjusted for maximum plate voltage swing. Under these conditions, an efficiency of 60 to 65% should be readily attainable. For the 6JB6 this means at least 70 or 80 volts peak-to-peak should be available at the grids. I would not recommend the use of speech compression with these finals since this would raise the average plate dissipation and the tubes are already running near the hairy edge. This would be allowable with 6146B's running at the same input.

The receiver alignment consists of peaking all the tuned circuits at 50.2 mhz which gives a uniform response from 50.0 to 50.4 mhz. Likewise, the 14 mhz bandpass filter between the 6J6A and the 12BE6 should be peaked at 14.2 mhz. The easiest way to peak the bandpass circuits is to first short one coil and grid-dip the other to the proper frequency. Next short the one you have just dipped, and dip the one which was previously shorted. The short should then be removed and the coils peaked up on an incoming signal in the middle of the tuning range. The short can be a piece of heavy bus wire tack-soldered onto the coil terminals. It is not necessary to use a signal for peaking. This can be done with atmospheric noise and the performance will be just as good. This is about all there is to the receiver section alignment.

For the initial transmitter alignment the final tubes should not be in their sockets. In all the following procedures the tuning indicator used is an *rf* probe coupled to the tank circuit through a small capacitor of .5 to 1 pf. A grid-dip meter operating as a wavemeter can also be used, but it is more cumbersome. The 20 meter 12BE6 mixer plate coil slug should be peaked with the tuning dial at 14.4 mhz and the exciter tune capacitor almost at minimum capacity. The crystal oscillator tank coil and the mixer and driver plate coils should be grid-dipped to 50 mhz to bring them into the right ballpark. The crystal oscillator tank circuit is peaked for maximum transmit mixer output which should be measured by the above method.

The driver plate tank should be dipped with a capacitor of about 60 pf temporarily connected from the tap to ground to simulate the final's input capacity. This will be removed when the finals are installed. The tuning dial should now be set at 14.2 mhz. The 6KE8 mixer and driver plate coils should now be peaked for maximum output. The 60 pf capacitor should now be removed and the final tubes placed in their sockets.

Some sort of dummy load at about 50 ohms is required for the final touch-up of the transmitter circuits. The final should be neutralized by any of the standard methods found in the handbooks. The final touching up is accomplished by turning on the transmitter for short periods of time (not more than 30 seconds at a time) and peaking the tuned circuits for maximum power out. Keep the pi-network tuned for maximum power output but don't exceed 300 mils of plate current. The 36 mhz oscillator plate tank should also be peaked again. If you have a wattmeter for this frequency it should indicate at least 100 watts output. It should also be noted that when the final is properly neutralized, maximum power will occur at the plate current dip. Adjust the neutralizing capacitor until this condition is



Overall angle view of the chassis. The driver, 6KE8 mixer and final amplifier compartment are more clearly identifiable.

attained. Resting current for the 6JB6's is about 50 mils. Once the unit has been adjusted, the tune-up procedure for normal operating is exactly the same as given in the manual for the low bands.

One question remains: What to do about the hole in the front panel where the bandswitch used to be? I solved the problem by mounting a BNC jack in the hole and running the 14 mhz *if* out to my 80 thru 10 meter receiver. This gives independent transmit-receive capability which is a great aid when working AM stations. The 14 mhz pickup is two turns of wire wound around the ground end of L9 and brought to the front panel by means of a length of miniature 50 ohm coax. This gives quite adequate injection for the external receiver. I suggest an external *if* receiver if much work is to be done on AM since the SSB selectivity of the crystal filter is a little too sharp for good AM reception.

On the air reports have been gratifying. The single sideband emission is clean, and the audio is crisp and clear. The AM mode also has produced good reports. 30 watts of carrier output is a good competitive signal on six meters. With this unit I am not afraid to try other circuits and improvements in it, since the purchase price was far below any similar commercial unit. In my estimation it performs as well as, if not better than, the comparable commercial unit.

. . . WA1FRJ

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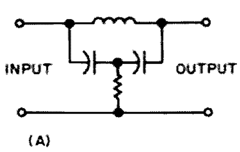
IF Notch Filter

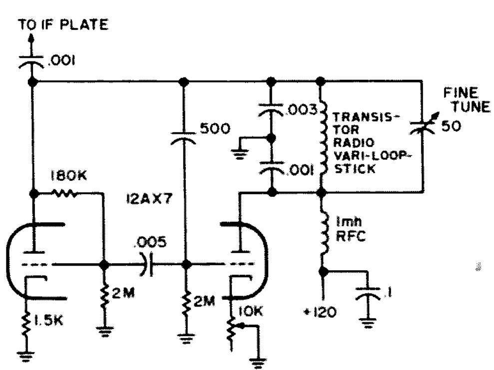
IF notch filters represent one of the last selectivity refinements possible in many SSB receivers. Found in many expensive receivers, they can be incorporated into most receivers or transceivers as an accessory.

Notch filters in the *if* amplifier chain of a receiver are not a new idea. The popular Q Multiplier could be made to function as either a peaking or notching filter simply by altering its feedback arrangement. However, in the days when the Q multiplier first became popular, the notch function was generally overshadowed by the peaking function since it was desired to mainly improve the selectivity of a receiver. As even less expensive receivers tended to use better selectivity devices, particularly crystal filters which provided good shape factors, the Q multiplier decreased in popularity. The bandwidth and steep skirts of the filters reached an optimum point for SSB reception and use of a peaking Q multiplier simply introduced distortion in selectivity. It was at this point that at least some operators discovered the very useful and somewhat forgotten notch function of a Q multiplier. Although it was no longer possible to eliminate QRM on SSB by reducing the *if* bandwidth in a receiver without severely losing voice identity and intelligibility, it was possible to eliminate narrow frequency bands where QRM was present without affecting voice intelligibility to any great degree. The situation is very similar to various combined voice/teletype transmission systems where a 80 to 150 cycle slot is placed in the 300 to 3000 cycle total bandwidth for teletype transmission.

The usefulness of a notching device across



(A)



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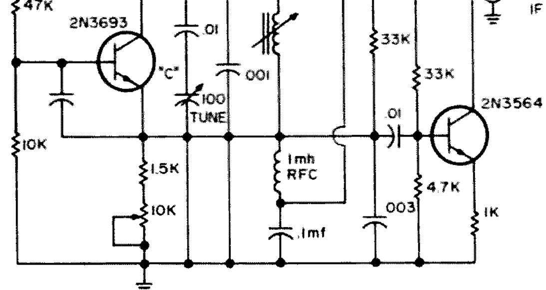

Fig. 1. Bridged-T network (A) is basis of most notch filters. Q multiplier in notch function uses network in feedback circuit. (C) varies notch frequency approximately ±6 khz from 455 khz center frequency.

the *if* bandwidth is indicated by the fact that many of the better and more costly receivers which already incorporate optimized *if* SSB filters also incorporate notch filters, since it is the only means left to eliminate QRM without causing distortion. Notch filters have been improved and simplified considerably in recent years. They can be a very useful accessory to add to a receiver or transceiver which already has a good *if* filter. They are a particularly appealing accessory to add to a transceiver which is used on both SSB and CW but which has only a SSB filter since they provide that extra bit of QRM rejection so necessary when a SSB transceiver is used on a crowded CW band.

This article surveys various notch filter configurations used in amateur receivers. The reader who wishes to should be able to adopt the various circuits to his own needs. The parts needed can all be purchased or fabricated. In place of the latter, some of the more critical components might be available direct from receiver manufacturers.

Basic Notch Circuits

Most notch filters are based upon the Bridged-T network shown in **Fig. 1(A)**. The network is balanced at the frequency at which it resonates and theoretically offers infinite attenuation between input and output terminals. At other frequencies, it is unbalanced and these frequencies pass through. The degree of attenuation at the notch frequency depends, in practice, upon the Q of the components used but can approach as high as 60 db.

The old Q multiplier notching amplifier (**Fig. 1B**) made use of a network in a feedback arrangement in order to enhance the Q of relatively simple components. At the resonant frequency of the network a high negative feedback occurs to the first section of the 12Ax7. The feedback drops its plate resistance to a very low value and, in effect, at the one frequency it shunts the *if* line to ground. It acts similarly to a frequency selective switch. Although the general tendency in notch filters has been to eliminate the need for active networks by using passive components of sufficiently high Q, the single point connection of the old Q multiplier circuit to the *if* circuit still gives it an unique advantage.

Notch filters can be built for any *if* frequency within the limits of achieving frequency stable circuits. With care they can probably be used up to frequencies of a few megacycles, although most designs have been made for frequencies below 1 megacycle. Fig. 1(C) is a good example of a transistorized notch filter design in a recent receiver design.

Typical Circuits

Fig. 2 shows three notch filter circuits which utilize only passive components. The filters may be placed at almost anyplace in the *if* chain but after the main selectivity (crystal or mechanical filter). The loss they introduce (at other than the selected notch frequency) is usually low enough so that no additional amplification need be provided as compensation.

Fig. 2(A) shows a tightly coupled *if* transformer used between the filter terminal. Instead of the common point of the transformer going to ground, however, it is coupled to the bridged-T network in slightly modified form. The impedance transfer is

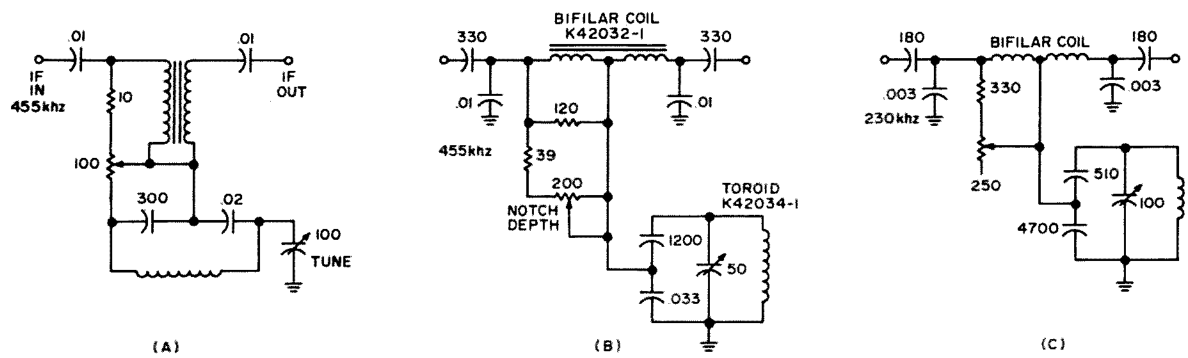

Fig. 2. Most receivers now use notch filters having only passive components. Basic circuits shown are from Davco DR-30 (A), Hammarlund HQ180 (B), and national HRO-500 (C).

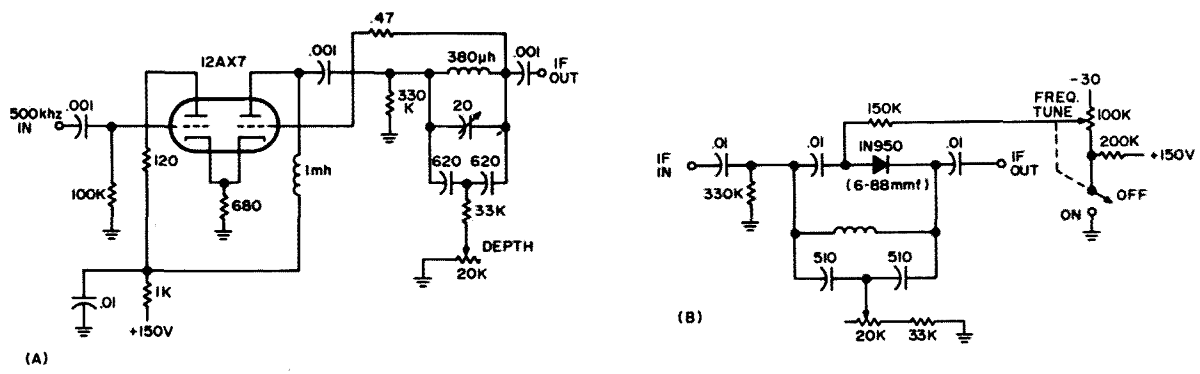

Fig. 3. Notch filter using a feedback amplifier to increase Q of series bridged-T network. Instead of air variable capacitor, varactor diode can be used (B) controlled by potentiometer.

low except at the frequency to which the filter is resonant. The sharpness of the notch depends a great deal on the Q of the coil used, which is wound on a ferrite core. Figs. 2(B) and 2(C) are similar circuits except that they utilize bifilar wound coils to achieve close coupling. The tuning capacitors are chosen such that the notch frequency can be varied several kilocycles either side of the *if* center frequency. The resonant circuit presents an impedance to the center of the bifilar coil so that zero coupling occurs at the notch frequency. The resistors provide a resistive balance to the bridge network and can be varied for notch depth (usually set at maximum depth and left as a chassis adjustment). The value of the bypass and coupling capacitors at the input and output of each network provide a proper impedance termination.

Fig. 3 shows two notch circuits which have been used in Collins equipment. Only the basic circuit features are shown. The circuit of Fig. 3(A) is basically a simple Q multiplier feedback arrangement as explained previously. The feedback circuit from the output side of the bridged-T network (which is in series with the *if* signal flow) going to the grid of the second half of the 12A x 7 enhances the circuit Q by a factor of 2500. A mechanical arrangement on the filter tuning capacitor shorts out the 380 µh coil when the capacitor is fully rotated in one direction (for filter "out" control).

Fig. 3(B) shows a very nice use of a varactor diode in a notch filter which can be applied to other circuits as well. When the 100 K potentiometer is turned such that the switch is in its "off" position, the IN950 is forward-biased by the plus 150 volt supply. Effectively, its low forward resistance shorts out the notch filter. When the potentiometer is turned "on" reverse bias is applied to the IN950 and it functions as a capacity diode to tune the notch filter frequency.

Summary

A notch filter can be one of the most useful selectivity devices which can be added and still improve the receiving ability of even a good piece of equipment, especially a SSB transceiver with no CW filter option. By combining some of the ideas presented, it should be possible to come up with a solution for almost any situation. The use of a varactor diode to remotely tune (by means of a panel-mounted potentiometer) a filter should alleviate any component location problems.

A great deal of the effectiveness of the filter depends upon the Q of the resonant circuit used. The use of inexpensive transistor radio ferrite antennas (Miller 2000 series, for instance) solves many needs for low-frequency *if*'s. Those having Q's of 250 or less are suitable for use in circuits having a feedback arrangement to enhance the Q. Those having Q's of 400 or more can be used similarly or even alone in passive circuits with moderate success. However, for completely passive circuits, it would be better to use higher Q inductors. Such inductors can be built using litz wire on such forms as Indiana General Corp. ferramic cup-core assemblies which can provide Q's of 850 up to 500 kc. For higher frequencies, ferramic toroids can be used.

. . . W2EEY/1

Calibrate That Homebrew Dial

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Whenever a new piece of homebrew gear is finished, it is often necessary to give a degree of reliability and resettability. However, the necessary laboratory equipment is not available to the majority of amateurs. Thus, makeshift methods are often attempted with a makeshift result. Although a simple method of achieving reliable calibration is available, many amateurs are not aware of it, or have forgotten how to use the method.

Older amateurs who are familiar with the old HRO series of receivers and various older pieces of test equipment will recognize the technique that I am going to outline. What is it? The use of a frequency versus logscale graph. The older HRO receivers had such a graph on each of the plug-in coil units. Reading of frequency consisted of reading the log scale on the receiver and referencing this to the graph. Such techniques may be used to create a graph for a piece of gear that has been recently constructed. This graph then can be used to accurately calibrate the final dial or retained for use with the log scale per the old HRO's. By the way, this technique does not apply just to receivers. It applies to any tuneable oscillator using any combination of L-C arrangements including permability tuned coils as well as the conventional fixed inductance variable capacitance oscillator tuned circuit.

The technique consists of using a series of known points such as crystal frequency, broadcast stations, etc. plotted on graph paper. The plot then can be used to create a dial with direct calibration points marked on it. Of course the more known points, the more accurate the final graph, but a small number is better than none.

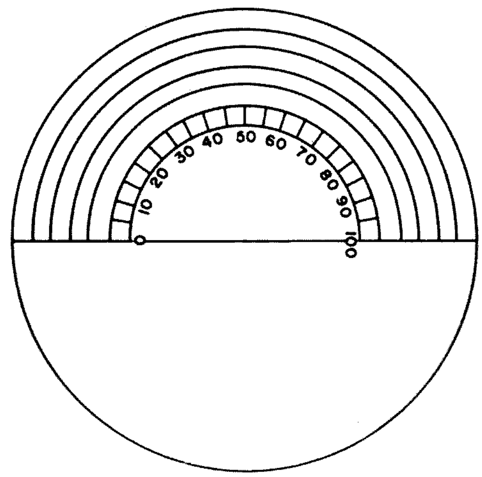

Fig. 1. Dial with 0-100 log scale.

How to do it? First of all construct a dial with some type of linear log scale on it. Such things as protractors may be used. A protractor will give 360 equally spaced log points on a circular dial. Or a 0-100 log scale similar to **Fig. 1** may be used. These types of log scales apply to both circular or semicircular dials. A slide-rule dial is much easier to achieve a log scale on. This is accomplished by use of the simple ruler. Each division on the ruler may be used as a log point on the dial.

The next step consists of locating the position of known frequency points on the log scale. In the case of a receiver various crystals, stations, etc. may be recorded. In the case of a VFO, GDO, Signal Generator, etc., it is necessary to use some type of receiver which will receive the known frequency and the output of the unit being calibrated. All that must be done is to beat the known frequency and the output of the

unit until zero-beat. The log position on the dial is recorded and the next frequency checked. Don't forget that harmonics can be used. Their accuracy is usually quite sufficient.

The third step consists of laying out the frequency versus log-scale graph. Any form of quadrilled paper may be used. The graph paper appearing in the back of the log book is fine (now you know what this is for!!!). I prefer the K & E 358-12 8½ inch x 11 inch paper, but any type of paper should be sufficient. First label the bottom of the sheet in equal divisions with the log-scale in use. Next label the vertical axis with the frequency range. Make sure that the frequency divisions are equal, e.g., 100 khz per division, 1 mhz per division, etc.

The fourth step consists of plotting the known points on this set of axis. For example, if 7035 khz were at 79 on the log-scale, it should be placed at the intersection of the lines from 7035 khz and 79 on the respective chart axis. The remaining points should also be plotted.

The fifth step is to connect these points with a smooth curve that fits the points plotted. A draftsman's French Curve is best for this. This instrument is available for less than $1 from many sources. The sixth step is the actual calibration of the final dial. The usual points, e.g., every 10 khz, 100 khz, etc., may be found by following the line from that point of the vertical axis until it crosses the curve. At the point where it crosses the curve, the line coming from the horizontal log-scale axis will give the correct position of this frequency on the log scale of the final dial. This can then be marked and successive points laid out.

In the case of seldom used pieces of gear, especially those using the inexpensive vernier dials, the graph can be retained and the dial not directly calibrated. In fact, this is about the only way with the dials which have the metal circular dial calibrated in a 0-100 log scale. When a certain frequency is desired, it is checked on the graph and set on the log scale on the unit. In fact, this is the way that the good old BC-221, LM, and other surplus units work.

As an example of calibration, the actual points used in the calibration of a home-

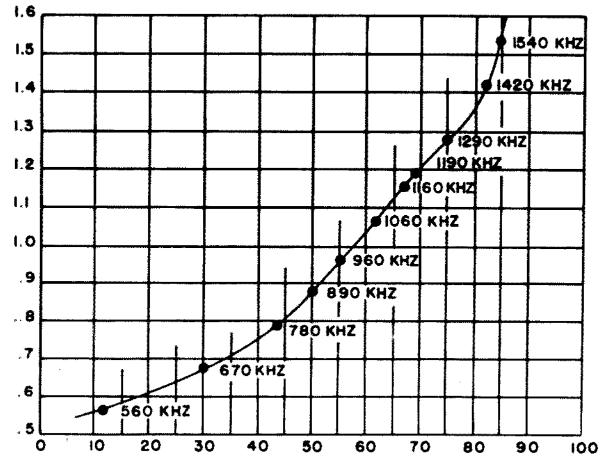

Fig. 2. Graph showing plotted calibration curve.

brew, all-band communications receiver used at K9STH will be listed. For simplicity only one band, the standard broadcast band, will be listed.

First the following stations were logged at the respective log positions on the dial:

Station	Frequency	Log Scale
WIND	560 khz	11.0
WMAQ	670 khz	30.0
WBBM	780 khz	42.0
WLS	890 khz	50.0
WSBT	960 khz	55.0
WHFB	1060 khz	61.0
WJJD	1160 khz	67.0
WOWO	1190 khz	69.0
WNIL	1290 khz	75.0
WIMS	1420 khz	82.0
WLOI	1540 khz	86.5

Next these positions were plotted on the graph paper per **Fig.** 2. The points were then connected with a smooth curve.

It will be noticed that a portion of the graph appears to be a straight line. This is what is referred to as the linear portion of the graph. By using only this portion of the tuning range, it is possible to achieve even marks on a dial such as in the Collins equipment, the new Heathkit equipment, and other pieces of amateur radio gear.

The only thing remaining is the final preparation and lettering of the dial. Some homebrewers type the figures in, others use decals or dry transfers; still others hand-letter. This I leave to the discretion of the individual amateur, for everyone has his own pet method which is just as good as the next. Good luck!

. . . K9STH/5

A Procedure for the Reception of Slow Scan Color Pictures Using Additive Synthesis

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The subtractive synthesis approach outlined by Cohen and Tarr (to be published) provides one method for producing slow-scan color pictures. At the same time these authors were experimenting with their process, I was investigating the use of additive synthesis and was fortunate enough to achieve results within a few days of their pioneering effort. Since Cohen and Tarr present an excellent analysis of both subtractive and additive color theory, I am confining this article to a simple description of the methods employed in my own experiments.

The camera used to produce the original color recording is similar to the one described by MacDonald (1965) except that it employs a conventional vidicon instead of the special slow scan type originally specified (Taggart 1968, Hutton 1969). Despite the fact that the 6326 vidicon used has a better spectral response than many other types, it was still found to be rather difficult to get good color separation when direct analysis was used. To bypass this problem, a conventional 35mm camera with Plus-X film was used in conjunction with the red, green and blue primary color filters to produce three color separation prints. One print represented the color pattern as seen through the red filter, another as seen through the green filter, and the last as seen through the blue filter. These black and white photos were then used with the slow scan camera to produce the analysis tape. Approximately ten frames of each print were recorded. The resulting tape now contains all of the information required to synthesize the picture and may be mailed, sent via landline, or transmitted over the air. The actual synthesis of the picture involves several discrete steps:

(1) The tape is played back through the monitor and a photograph is made of a red, a green, and a blue frame. A 35mm camera with Plus-X film is most convenient.

(2) The three negatives of the red, green, and blue frames are then used to make 4" x 5" positive transparencies. If Polaroid positive transparency film is available, these positives may be made directly from the monitor display.

(3) The positive transparencies are carefully superimposed and two pins thrust through the negative stack at points along the upper margin. These are the "key" points which will be used to assure exact registration of the finished image.

(4) The Polaroid camera is loaded with Polacolor film and securely mounted in relation to the negative frame (see Fig. 1). The "red" transparancy is then hung in place on the frame using straight pins in the key holes. The red filter is put in place and a

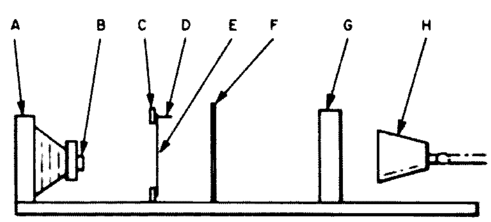

Fig. 1. Apparatus used at WA2EMC for final color picture synthesis. A—Polaroid camera with Polarcolor film. B—close-up lens. C—support frame for positive transparency. D—straight pin. E—positive transparency. F—ground glass screen to diffuse light. G—lucite cell for appropriate filter solution. H—tensor lamp. A and C should be mounted rigidly in relationship to one another so they do not shift between or during the multiple exposures. The distance between them will depend on the focal length of lens B.

single exposure is made on the film. Moving neither camera nor film, the red transparency and filter are removed and the green substituted. If the same pinholes on the frame are used to hang the green transparency, exact superposition is assured. The green exposure is then made and the entire process repeated for the blue transparency and filter.

(5) The Polacolor frame, now containing a three color triple exposure is then processed as directed. Small shifts in color balance may be achieved by varying development time – slightly short development emphasizes reds, while developing slightly longer then directed brings out the blues and greens.

Using the above procedure, no effort need be made to control the exposure time for each of the color exposures since this is done automatically by the camera electric eye. Large shifts in color intensity may be made by changing the density of the appropriate filter. I used the same filters for both analysis and synthesis. The filters consisted of lucite cells containing solutions of ordinary household food colors. The use of dye solutions allows ready manipulation of filter density.

All in all, the additive procedure provides a flexible method of picture synthesis with a minimum of darkroom equipment. The use of Polacolor film in the final stage allows the results to be seen immediately and an acceptable print is usually possible after only a few test exposures. If Polaroid film is used throughout, the total time from picture readout to a finished color print can be as little as a few minutes. This additive procedure and the subtractive synthesis of Cohen and Tarr provide a relatively broad base for further experimentation with this interesting mode.

. . . WA2EMC

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A Remote VFO for the HW32A

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If you have an HW32A transceiver and wish to make a versatile remote vfo for it with minimum expense, read on!

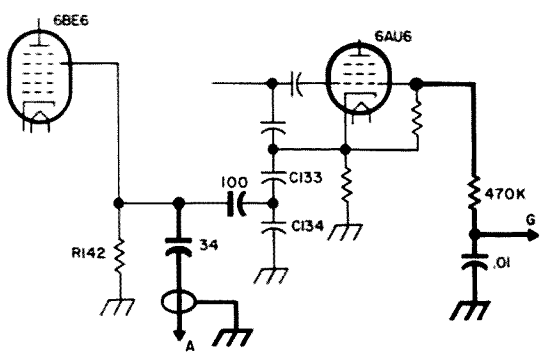
Some time ago I was fortunate enough to acquire an HW32A transceiver. This was my first introduction to SSB. The frequency range of the transceiver was changed so that the transceiver covered 14.10 to 14.25 mhz. After spending a number of enjoyable months on SSB, it was felt that a remote vfo for the transceiver would be very desireable specially for working split-frequency into the American phone band.

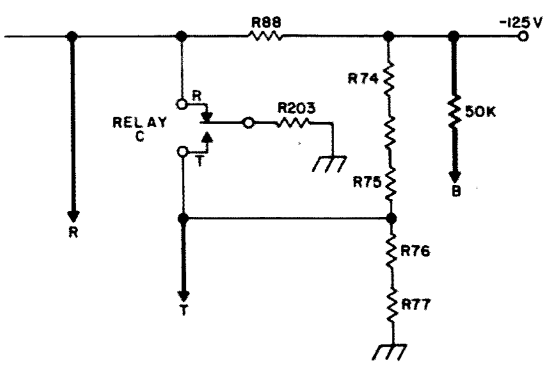
My friend, HB9TL, had already made some changes in the HW32A for me, for crystal-control of transmit frequency. But this mode of operation was not very flexible and the receive and transmit frequencies had to be close together. Nevertheless the changes done by HB9TL provided the ground-work.

After some experimentation the transceiver circuit was changed as shown and an external vfo was constructed as shown in Fig. 2. The circuit of the external vfo is straight-forward and as a matter of fact, any stable (tube) vfo giving enough output and being tuneable over 1.62 to 1.92 mhz may be used.

A 9-pin socket should be installed on the back apron of the transceiver and wired up as shown in **Fig. 1**. Modifications are shown in bold line. The changes in the transceiver circuit board involve:

1. Interchanging the physical position of R142 with C134.
2. Cutting of the printed circuit at a point between C134 and R142. This can be done with a sharp knife and care must be taken not to damage the circuit board.





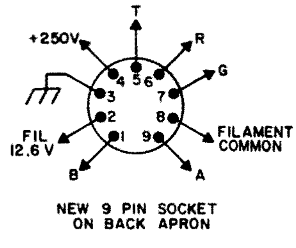


Fig. 1. Modifications to the circuit of the HW32A (shown in bold lines).

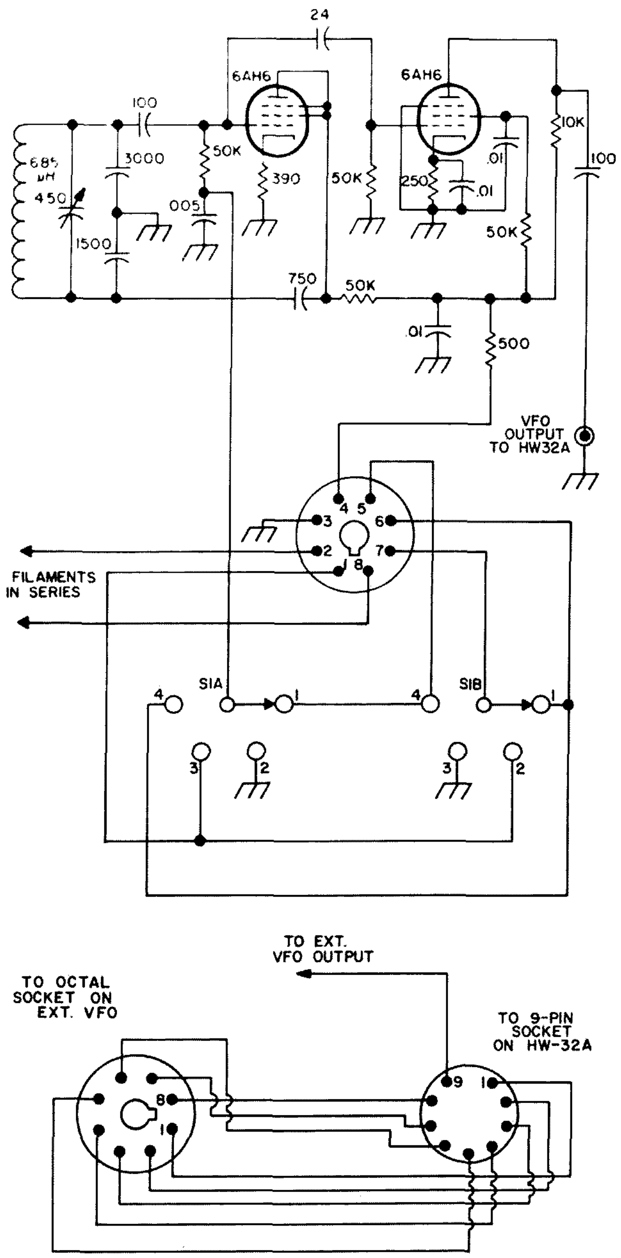


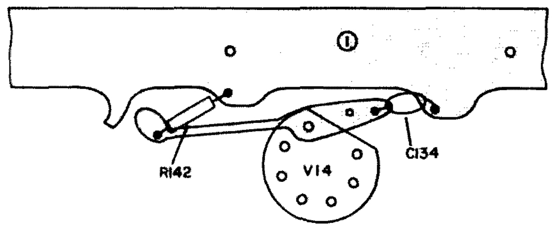
Fig. 2. External vfo and interconnecting cable.

3. Bridging the gap in the circuit board between C134 and R142 with a 100 pf mica condenser.
   These changes are shown in Fig.3.

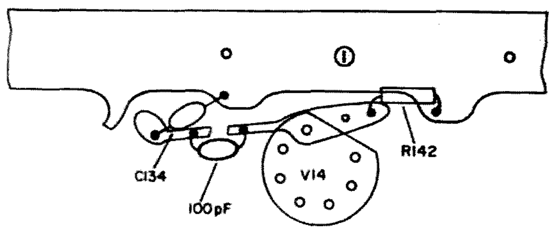
The 4 position switch in the remote vfo provides the following modes of operation:

1. Receive on HW32A vfo and transmit on remote vfo.
2. Transceive on remote vfo.
3. Transceive on HW32A vfo.
4. Receive on remote vfo and transmit on HW32A vfo.

The remote vfo has been tried out with the HW32A with a frequency differential



BEFORE MODIFICATIONS



AFTER MODIFICATIONS

Fig. 3. Circuit board modifications.

of 150 khz without any noticeable degradation in the signal strength. Apart from the flexibility of being able to work split frequency or transceive, the remote vfo makes it possible to use the whole band from 14.00 to 14.35 mhz as against the 150 khz allowed by the HW32A.

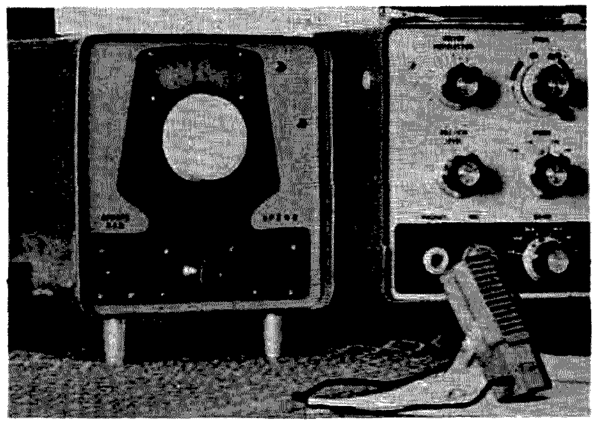
It might be necessary to re-calibrate the HW32A vfo by decreasing the vfo trimmer (C1318) capacitance a little. Even if it is not done, the capacitance introduced by the remote vfo does not change the calibration appreciably.

Unfortunately no photos of the inside of the remote vfo can be given as it has already been dismantled and is being converted into a companion remote vfo for the HW100, the new station rig. A photo of the outside is given showing the home-brew dial and the position of the mode switch.

Operation of the remote vfo is as follows:

1) Mode switch in position 1.
   a) While receiving approx. -50v, cut off bias is applied through relay C and S1A to the grid of the external vfo tube, 6AH6, and at the same time the cut off bias on the HW32A vfo tube, 6AU6, is removed through relay C and S1B.
   b) While transmitting cut-off bias is applied to 6AU6 and the cut-off bias is removed from 6AH6.

   Consequently the HW32A vfo determines the receiving frequency while the external vfo determines the transmitting frequency.



2) Mode switch in position 2.
   Cut off bias is applied through the 50K resistor and S1B directly from the -125v line to the grid of 6AU6, while the bottom end of the 6AH6 grid leak is grounded through S1A, and so the remote vfo determines both receive and transmit frequencies (remote transceive operation).
3) Mode switch in position 3.
   Cut off bias is now applied through the 50K resistor and S1A directly from the -125v line to the grid of 6AH6 while 6AU6 oscillates for HW32A transceive operation.
4) Mode switch in position 4.
   a) While receiving cut-off bias is applied through relay C and S1B to 6AU6 grid and the external vfo (6AH6) is operating.
   b) While transmitting the cut-off bias is applied to 6AH6 through relay C and S1A and the HW32A vfo (6AU6) is operating. That way HW32A vfo takes over while transmitting and external vfo while receiving.

From the above description it can be seen that all switching is done by the already existing vox relay of the HW32A. No switching of the circuits carrying rf is involved. The four position switch in the remote vfo merely selects the mode of operation.

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National City, CA 92050

Cheap and Simple for Six

Here is a six-meter converter that has been designed for maximum simplicity and low cost. It uses three vhf bipolar silicon transistors in the common *rf* amplifier-mixer-oscillator arrangement. Surplus switching transistors were used to provide low cost, but if parts are bought new, transistors designed for use in FM broadcast receivers can be used. If the parts are bought new, it should be possible to build this converter for $12 or $13. Since the crystal makes up almost half of this price, a surplus crystal can cut costs considerably.

The Circuit

50 mhz signals from J1 are coupled to the base of Q1 by LI in Fig. 1. D1 and D2 help to prevent burnout of Q1 when the voltage across LI exceeds about 0.2 volts. Q1 is a neutralized common emitter amplifier. The 10 pf capacitor from L2 to the base of Q1 and the 560 pf bypass on L2 provide neutralization. These values are determined by experimentation. L2 couples the collector of Q1 to the base of Q2, the mixer. Q3 is a Peirce overtone oscillator which is also coupled to the base of Q2 through Cx. The 50 mhz input signal and the 49 mhz oscillator signal are mixed in the mixer to produce the difference frequency of 1 mhz in the output at J2. The *rf* choke in the collector of Q2 is used to avoid using another tuned circuit here. The gain is ample without any effort to match impedances. If a crystal other than 49 mhz is used, only L3 need be changed to provide for the different output frequency.

Construction

Fig. 2 shows the printed circuit board layout and parts placement. If you have done a lot of PC board work, you will

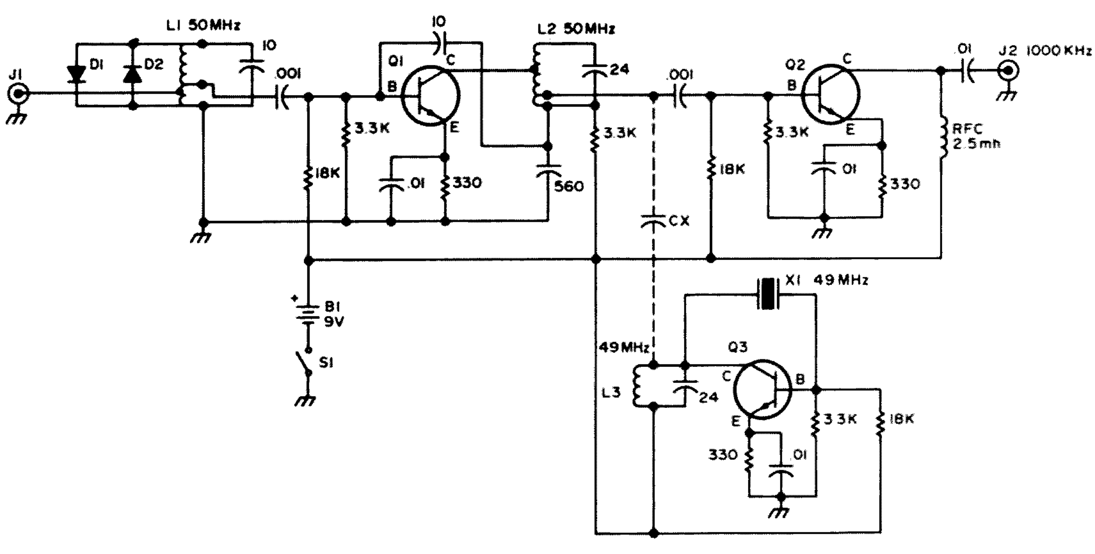

Fig. 1. Six meter converter schematic. Refer to the text for unmarked components.

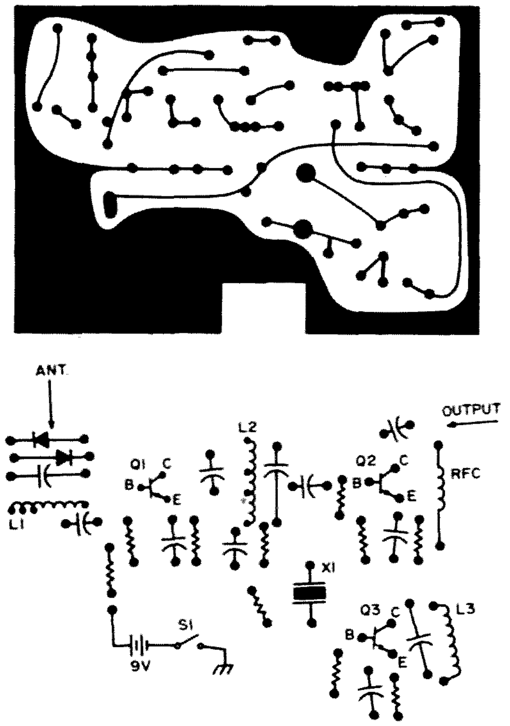

Fig. 2. Printed circuit board and layout. Refer to Fig. 1 and text for parts values.

probably want to use a printed circuit board for your converter. Once the layout is determined, making the board and soldering the components is easy. However, the initial cost of a good printed circuit board kit is high, and would probably not be desired for just one project. Perforated board is available if you decide not to use a printed circuit board.

The next thing to worry about is winding the coils. The wire is enamel covered and about No. 21 in size. The coils are wound on a pencil which is removed after winding. L1 is thirteen turns tapped at three and four turns from the bottom. J1 connects at the third turn from the bottom. L2 is ten turns tapped at three and four turns from the bottom. The fourth turn goes to the collector of Q1. L3 is nine turns.

Diodes D1 and D2 are 1N34A's. Some type of high speed switching diode would probably be better, but the 1N34A was available at the time. In the original version a 2N708 was used for Q1, and 2N917's were used for Q2 and Q3. They were randomly selected from the junk box, but if transistors are bought new, I suggest the 40242, 40243, 40244 series. The 2N3478, 2N4259, 2N706A, or almost any other vhf silicon NPN transistor could also be used. The stable bias circuit will allow for changes in transistor characteristics.

XI is a 49 mhz overtone crystal. Other crystals in the 40 to 50 mhz range were tried with equal results. If the 49 mhz frequency is used, output from the converter will be in the AM broadcast band, making the converter usable as a mobile receiver with a car radio. Cx is the coupling capacitor from the crystal to the mixer. It consists of two pieces of hookup wire twisted together to form a gimmick capacitor, and it is soldered on under the printed circuit board. The wires can be about one inch long.

The board is mounted in a 4 by 3 by 2 inch aluminum box. A shielded box is recommended to help prevent *if* signals from going through the converter directly to receiver. The board is mounted with solder lugs soldered to the grounded outer foil of the PC board. The other end of the solder lug is bolted to the side of the box. A total of four solder lugs is used for this.

SI is a d. p. d. t. slide switch. Any small switch will work here so long as it will fit into the box. If the switch were mounted differently, or a different switch were used, the cut out in the circuit board might not have been necessary. The battery mounting problem is the next segment of the construction. There almost wasn't enough room for the battery. The battery is of the standard nine volt transistor radio type, and was mounted with a small dab of glue on the inside of the aluminum box. Battery holders are available, but are expensive and take up space. A connection between the battery and the circuit board is still necessary, however. For about 13 cents you can buy a connector which will fit the battery. Be sure you check the polarity of the leads coming from the plug; the color of the leads is sometimes confusing.

The last things to be mounted after the board is in the box are the input and output connectors. I used a phono jack for the output and a BNC connector for the input. These items happened to be available and they fit well in the small space. After the connectors are mounted it may be difficult to get the board in and out.

Alignment

A grid dip meter is required for tuning

the converter. First check for output from the oscillator coil, L3 at the crystal frequency. If output is not detected, the coils can be tuned by a process called "knifing." The knife is made of a non-metallic tuning wand or other kind of insulated shaft. A small brass slug is attached to one end and an iron ferrite slug is attached to the other end. The brass slug can be obtained from a brass bolt, and the iron slug can be removed from a slug tuned coil form. When the brass end is inserted in a coil the inductance of the coil will decrease and the resonant frequency will be higher. The iron slug will lower the resonant frequency of the tuned circuit. By using this method and watching the output, you can determine whether the coil should be compressed to lower the frequency, or expanded to raise the frequency. Be sure to use a weak signal for final tuning. The tuned circuits should be close enough to the proper frequency for the converter to work before any tuning is done. The tuning should be rather broad and noncritical.

Results

When used with a good receiver the sensitivity of the converter is very good, and the leakage from a Heathkit signal generator with the output at zero almost pins the S meter of the receiver. The main disadvantage of using bipolar transistors is cross modulation. A nearby FM broadcast station can be heard at spots on the dial. There is also some feedthrough into the converter *if* frequency. In this case, however, six meter signals, ignition noise, and power line noise have usually been stronger than the spurious signals. Changing the *if* output frequency by changing the crystal frequency might relieve the problem of BC feedthrough, but it is mainly a problem of shielding the leads from the receiver to the converter. Using an FET for Q2 would improve the cross modulation characteristics of the converter, but would increase the cost.

This converter was built with the idea of saving money. If you have a well stocked junk box and an afternoon or two, it shouldn't cost more than a few dollars to throw it together. Considering the cost and the time spent on this project, I feel that it has given more than adequate results.

. . . WB6BIH

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The Mismatched rf Transmission Line

The matter of just how well a transmission line transfers power from a radio transmitter to a load, when that load is not matched to the transmission line, has been debated for many years. Few people feel certain that they know just what occurs. The amazing part of it is that very few radio amateurs have taken the trouble to set up a carefully controlled experiment to determine empirically the facts of the situation.

To settle this question, I built a setup to determine just what happens to radio frequency power sent over an unmatched transmission line. What I wanted to find out from this experiment was what happens to the power that leaves a transmitter and flows along a transmission line to a load that was not matched to that transmission line. How much power actually reached the load? What is the effect of this mismatched line on the tank circuit of the transmitter? And what is its effect upon the vacuum tube in the final amplifier of the transmitter?

To determine just what happened, I first built a source of 25 mhz power, carefully designing it to minimize harmonic output. It started out with an oscillator-tripler driving an amplifier on 25 mhz; this was link-coupled to another amplifier on 25 mhz. The second amplifier had a pi network in its output, which matched it to a 52-ohm transmission line going to a tuned grid tank circuit in the final amplifier. This final amplifier was grid-neutralized so that another pi network could be used in its output circuit. It used a triode tube, an Hk-254. I selected this tube because it is designed to run a shade of red during normal operation. Any overload will cause it to blush up to white-hot in a matter of seconds, yet it can stand this overload for quite some period of time. In other words, it is a very rugged tube that can stand a heavy overload yet still show visual evidence of even a slight overload. To keep harmonic generation at a minimum, only 1000 ohms of grid leak bias was used. The remaining bias was taken from an adjustable supply and was set for operation in the Class AB_2 region. With a harmonic-free source of 25 mhz power available, I was ready to conduct the experiment.

The first portion of this experiment was with a 300-ohm open-wire transmission line. I selected a length that was not a multiple of quarter waves. The purpose of this, of course, was to avoid introducing any repetitive or inverting phenomena. To measure *rf* power at the end of the 300-ohm transmission line, I used a termination consisting of two 150-ohm non-inductive resistors and a 0 to 1 radio frequency ammeter. (See Fig. 1 for the layout.) These

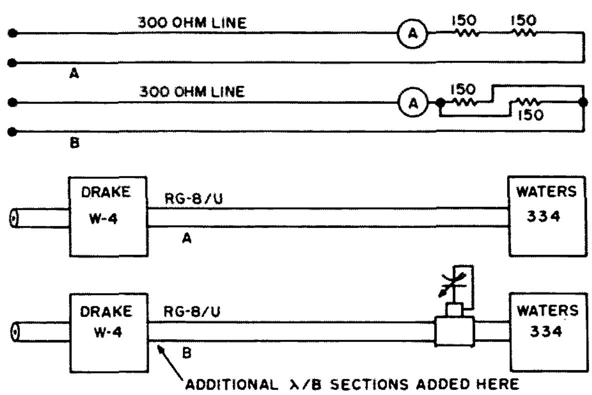

Fig. 1. Layout of lines and meters for the experiment.

two resistors could either be connected in series for a matched 300-ohm termination or could be connected in parallel for a 4 to 1 mismatch (75 ohms). This mismatch, of course, would result in a voltage standing wave ratio of 4 to 1.

With this done, I took a series of readings. First I loaded the transmitter to 165 watts input (125 milliamperes at 1325 volts). With the 300-ohm termination I measured 0.4275 A current which, by I^2R, indicated approximately 68 watts *rf* load. Note this was a matched load. I made note of the color of the plate of the HK-254. Next, I connected the two 150-ohm resistors in parallel, resulting in a 4 to 1 mismatch, and returned and reloaded the transmitter to exactly the same power input. Under this condition, I measured the current as 0.96 a. This also gave 68 watts *rf* power delivered to the load. The HK-254 showed the same color as with the matched load. The results show beyond doubt that the actual radio frequency power delivered to the termination is precisely the same even though there is a mismatch of 4 to 1 (a voltage standing ratio of 4 to 1) on an open-wire transmission line!

After having demonstrated this to my own satisfaction, I repeated the demonstration at a hamfest held at Lake Texoma (between Oklahoma and Texas) in fall of 1968. This demonstration aroused considerable curiosity and also raised the question of what would happen if one were using coaxial transmission line. That suggested the next segment of the experiment, which was presented as a demonstration before the Aeronautical Center Amateur Radio Club early in 1969.

The second portion of the experiment, involving a 52-ohm coaxial line, used a Waters 52-ohm wattmeter as the termination and a Drake *rf* forward and reflected power meter to measure power and VSWR at the transmitter's output. (Fig. 1 shows the set up.) Again I selected a length of transmission line that was not a multiple of quarter waves. In the initial tune up, I adjusted the transmitter to deliver 80 watts to the load, which required 150 ma plate current. This 80 watts was shown both by the Waters wattmeter and by the Drake forward and reflected power meter. (No reflected power, of course.) For the next portion of the experiment, I placed a variable capacitor in parallel with the Waters wattmeter, and adjusted the capacitor until I had a 4 to 1 voltage standing wave ratio on the line. I returned and reloaded the transmitter to 150 ma plate current. The Drake forward and reflected power meter now showed 130 watts forward power and 50 watts reflected power. Note that the increase in forward "power" is exactly equal to the reflected "power." In each instance, this "power" is fictitious, properly measurable in terms of "volt-amperes-reactive" instead of true (or work-producing) watts. The Waters wattmeter now showed 78 watts, a drop of 2 watts from the theoretical 80 watts which would have been present if there had been no losses. At this frequency (25 mhz, which is near the high end of the amateur High Frequency bands), the loss in a transmission line with a VSWR of 4 to 1 was only 2 watts out of 80. To make sure that this was not a freak condition based upon a length of transmission line, I added 1/8 wave length sections of coxial line in two stages, taking complete readings with the addition of each section of line. This did not in any manner change the VSWR shown by the Drake meter or the power delivered to the Waters wattmeter (after returning and reloading to the original power input, of course). In each instance, the HK-254 showed the same color as with the matched load.

What about the effect upon the radio frequency tank of the final stage? There was no effect. The coil did not heat up and the capacitors did not flash over. When I built this radio frequency power generator, I designed the plate tank circuit of the final amplifier to be quite flexible. This means that I used an input capacitor which would give a quite wide tuning range, and I used an output capacitor for the pi network large enough to cope with a wide range of impedances. These two things are necessary, because with the high voltage standing wave ratio and with a variation of transmission line length, the impedance presented to the output of the pi network may range over very wide limits. This necessitates a wide range of flexibility. In each instance I was able to reresonate the plate tank circuit

correctly and to reload it to precisely the same power input it had with a purely resistive (and correctly matched) load at the end of the transmission line.

What about the effect upon the final amplifier tube? As noted before, I used a tube that was very sensitive to any overload. Its plate would flare white-hot with the slightest maladjustment. In each case, when the plate pi network was returned to resonance and loaded to show the same power input, the tube visually indicated precisely the same amount of plate dissipation. This clearly shows that there was no extra load upon the final amplifier tube.

The conclusion from this series of experiments is that the effect upon a transmitter caused by working it into a transmission line having a 4 to 1 VSWR is indeed very small. Such a practice does, however, require that the tuning circuit in the output of the transmitter be quite flexible in order to match the wide range of impedances which may be presented to the transmitter. If this impedance matching capability is adequate, the vacuum tube (or tubes) in the final amplifier always will see a pure resistive load of the proper magnitude for optimum operation. They then will function in every manner just the same as they would if the transmitter were loaded into a proper-sized dummy load.

The findings of these two experiments leave unanswered the vivid questions in the minds of those who have had unpleasant experiences with transmitters connected to transmission lines having high VSWRs. Why will some transmitters load when others won't? Why will changing the transmission line length sometimes enable loading to an otherwise nonresponsive line? Why does the output capacitor of some transmitters flash over when the VSWR is high?

These are all valid questions. Each has a straight-forward answer, one compatible with the findings of the experiments. To answer these questions, it is first necessary to review a modest bit of transmission line theory, just to ensure a common point of understanding.

What happens along a transmission line, reaching from a transmitter to a load (antenna or otherwise), can be described in terms of watts, volts, and amperes . . . or, if you prefer, power, potential, and current. You are interested, primarily, in power; specifically, in power that reaches the load (antenna). All transmission lines have some loss. The transmission lines generally used by radio amateurs, unless inordinately long, have quite low losses when used in the High Frequency spectrum (3 mhz to 30 mhz). These low losses can become somewhat higher when the VSWR on the line becomes high. What is "high"? Most antenna specialists, those engineers who know whereof they speak, will tell you that in the HF band transmission line is constant (neglecting the very minor difference between sending end power and receiving end power that is attributable to actual losses, all dissipated as heat, in the transmission line), the relationship of voltage and current is constant only when the line is terminated in its characteristic resistance. Most transmission lines are not. And this is where we get our interest in VSWRs. Those changing relationships of voltage and current can result in three things that interest us greatly. At a point where the current is high and the voltage is low (the IE product remains constant, remember), some precious *rf* power is lost in the form of heat; the center conductor of the coax line has *some* resistance, and I^2R tells us the amount of power we're losing to heat. At the point where the current is low and the voltage is high, we lose some more power by way of dielectric heating; E^2R tells us how much. As mentioned before, these two losses are so small as to cause us no concern. Matching the impedances, though, that are presented at such points may be difficult. A point on a transmission line where the current is low and the voltage is high represents a high-impedance point. With a pi network, matching this sometimes results in a flashover between the plates of the output capacitor.

The third item, though, can give us much concern. It is the sending end impedance presented by the line. This impedance would be the characteristic impedance of the line if that line were terminated in its characteristic impedance. It seldom is. When it isn't (99.9999% of all instances), the impedance

seen at the sending end of the transmission line is dependent upon three variables: The frequency in use, the (electrical) length of the transmission line, and the impedance presented by the antenna at its feedpoint. You see, if you change the frequency of your transmitter one hertz, the impedance it looks into changes. Not much. But some.

You should keep in mind that the *electrical* length of your feedline is changed every time you change the frequency of your transmitter . . even one hertz. That electrical length is important.

Let's consider an example. Just to make things simple, let's say the feedpoint impedance of your antenna remains constant. (It doesn't, unless you're one of the one-in-a-thousand amateurs who uses a frequency-independent antenna.) And to make things even more simple, let's say your antenna presents a purely-resistive impedance to its feedline ... no capacitive reactance, no inductive reactance ... a highly-unlikely situation itself. Let's say too, that this resistance is four times the feedline impedance. Now, under even this hyper-simplified situation, as the effective (electrical) length of the feedline is varied (by changing frequency or by any other means), the sending end impedance will vary. If we were dealing with a 50 ohm line, the sending end impedance could be 200 ohms purely resistive, or it could be 12.5 ohms purely resistive. Or, more likely, it could be any value of resistance between those extremes plus some value of inductive reactance or minus some value of capacitive reactance.

This, then, is the prospective situation that causes the big arguments between the Engineering Design Division and the Marketing Division in manufacturing plants. The engineers would like to turn out a product they'd not be ashamed of, one that could cope with almost any sending-end impedance likely to be found at a transmission line. (No sane engineer hankers to tangle with the design of an output circuit that would match any random-length end-fed antenna ... and still satisfy FCC requirements for attenuation of spurious radiations.) The Marketing Division, however, has dollar signs dancing before its eyes. Versatility costs money. That extra cost gives competition a telling advantage. And amateurs have been conditioned to buy transmitters that'll cope with a 2 to 1 resistive (no nasty reactance) mismatch between feedline and antenna. So why commit financial suicide? All of this is good, sound logic. Look over the specifications of any transmitter on the amateur market, and you'll see who wins the arguments.

Now let's return to the verifications presented by the two experiments demonstrations. Here are the main points:

1. With open-wire feedlines, losses in the HF band resulting from VSWR of 4 to 1 are so low as to be unmeasurable.
2. With 52-ohm coaxial feedlines, losses in the HF band resulting from a VSWR of 4 to 1 are so low as to be wholly negligible.
3. With an output tank circuit capable of being tuned to resonance and loaded to the desired input power, the plate dissipation of the power amplifier tube is not adversely affected by a VSWR of 4 to 1.
4. The length of the transmission line, within any reasonable limits, has no bearing upon the VSWR or upon the power delivered to the load (antenna).
5. The electrical length of the feedline is highly important in determining the sending-end impedance of a feedline not terminated in its characteristic impedance.
6. The most important thing to consider is whether the output tuning circuit of your transmitter will cope with whatever impedance your transmission line presents to it at your operating frequency. If your transmitter will tune to resonance and will load to the desired DC power input, use it. Don't pay any attention to the VSWR. As long as your transmitter is "happy" (tunes as above), you can be happy, too. No harm will come to your transmitter by operating it under these conditions.

My thanks to William O. Todd W5UZX, for his help with the demonstrations.

. . . W5JJ

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BKX Bridge

Have you ever wanted to know how much reactance your antenna has and in which direction? Here is a radio frequency bridge, modeled after the General Radio 916-A that will do just that. It will tell you not only the resistance but the capacitive or inductive reactance of the circuit. Resistance is read directly in ohms regardless of the frequency of measurement and the reactance reading will be dividied by the frequency of measurement in mhz.

No attempt is made to give every little dimension because most of the parts that you will use will be from the junk box. Old broadcast variables, tin cans, etc., but you will be able to duplicate this bridge so that it will be a useful instrument with good accuracy.

Study the diagram and drawings until you understand how everything is wired and constructed.

The BKX bridge is built in an old Australian signal generator box that is lined with brass. Build the bridge with enough room for the mounting of the transformer. My box is a little too small and the

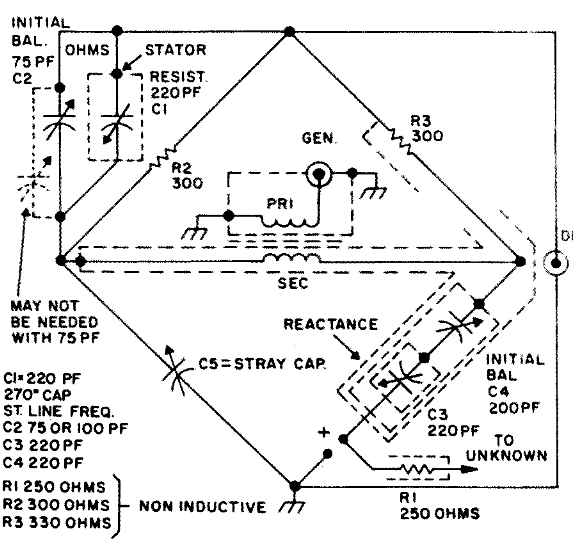
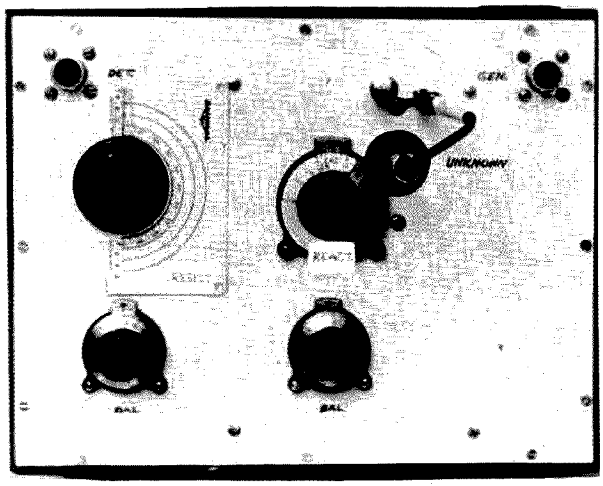


Fig. 1. Diagram and parts list.



Bridge panel. Resistance scale not calibrated as yet.

transformer is mounted on a stilt right up against the box shield. Photo No. 2 and **Fig. 6** show the exploded view of the transformer. Some dimensions are given so that you can duplicate it as closely as possible.

Construction of the transformer

Start with the inside coil form. Cut the brass foil in the shape indicated in **Fig. 6.** Use masking or plastic tape to insulate the ends about ¼ inch. The length of this piece is cut to go around the form with about 1/8 inch overlap. Fill the space with No. 20 hook-up wire. Solder one end of the winding to the foil, the other to the center conductor of the single conductor shielded wire. Lay in the outside foil with the one insulated end over the other insulated end and bend over the tabs and solder. The lead should be opposite the slit. Slip the 2½" pipe with the slit over and insert spacers so that the two do not touch. Solder the braid of the shield to this pipe. Keep all slits on the same side. Slip on plastic sleeve or spacers. Make reactance coil the same as the other. Insulate the brass tube with a slit using plastic or masking tape. Solder the lead-in, tabs, and slide the assembly over the first coil. The

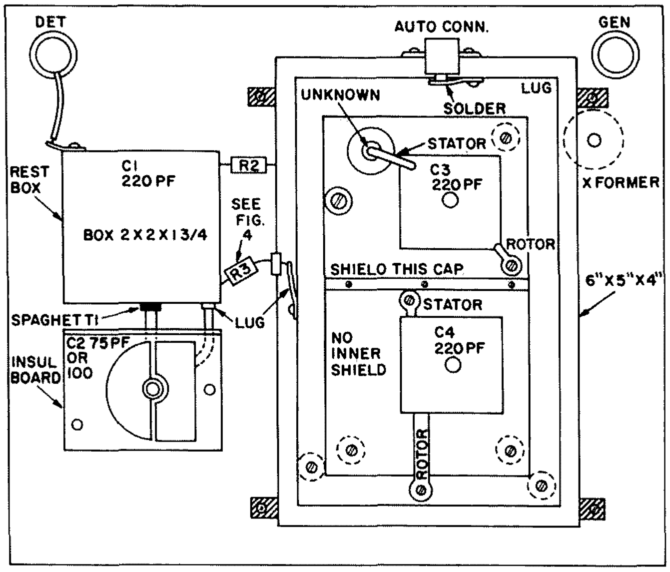
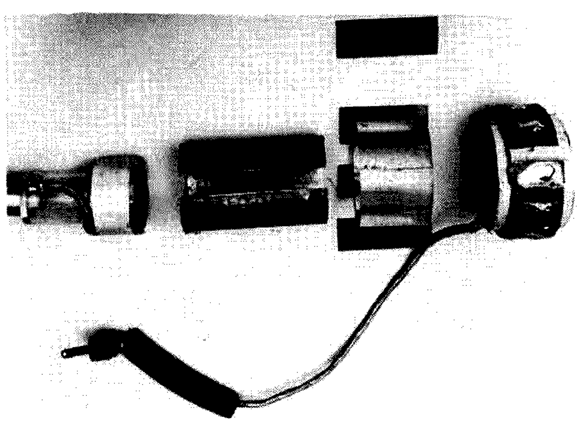


Fig. 2. Physical layout looking through panel.

dimensions don't seem to be too important. The large coil is between 2 and 2½ inches.

Reactance Box

The next item that needs some explaining is the reactance box, **Fig. 2 and 3 B.** This is actually made up of three boxes, one inside the other. Each must be insulated from the other as the diagram shows. The unknown lead from the capacitor C3 must be shielded by each box right up to the unknown terminal at the panel. See **Fig. 3A.** If your boxes are steel or brass, just solder the tubes into them. With aluminum, epoxy would probably work, or you might use 3 or 4 angle brackets to hold the tubes to the boxes, or press fit the tubes with insulated spacers between them. Insulated shafts must be used on all capacitors. The outside box of C3 is also insulated from the panel. Watch the insulation to see that it does not interfere with the tubes surrounding the unknown terminal. Note in **Fig. 3B** that the Motorola receptacle is so spaced that the inside terminal attaches to box No. 2 but the shell of the receptacle is insulated from it by a thin mica washer. Make this *rf* tight. This receptacle may be placed on either side of the box No. 3. The drawings show it in two different positions.



Transformer taken apart to show construction.

Reading from left to right (top of photo marked):

Plastic form with generator coil built upon it.

Pipe with slit.

Spacers to hold small coil away from pipe (under plastic spacer).

Large plastic spacer to hold large coil away from pipe.

Large coil built upon the brass tube and insulated from it by plastic or masking tape.

The lead with RCA plug goes into Motorola auto receptacle on the reactance can.

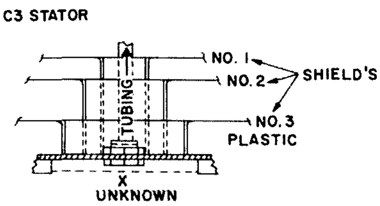


Fig. 3a. Reactance capacitor leadthrough to unknown terminal.

Pick your dials early in construction for you will need enough space between the panel and the capacitor cans to attach them. The small Japanese dials that I used attach to the panel first., then the reactance and resistance can is installed. Jackson Brothers drives would also work well, and you may make the dial larger if you watch the spacing of all the capacitors the reactance capacitor especially, and its shaft proximity to the unknown hole.

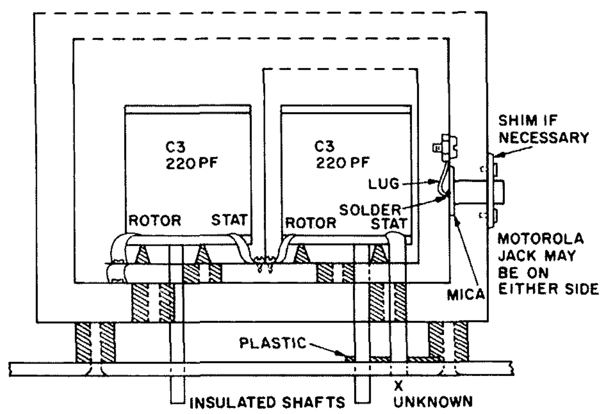


Fig. 3b. Reactance capacitor layout with construction ideas.

The panel is the original one from the signal generator box and has many holes in it so a paper overlay was used and lettered.

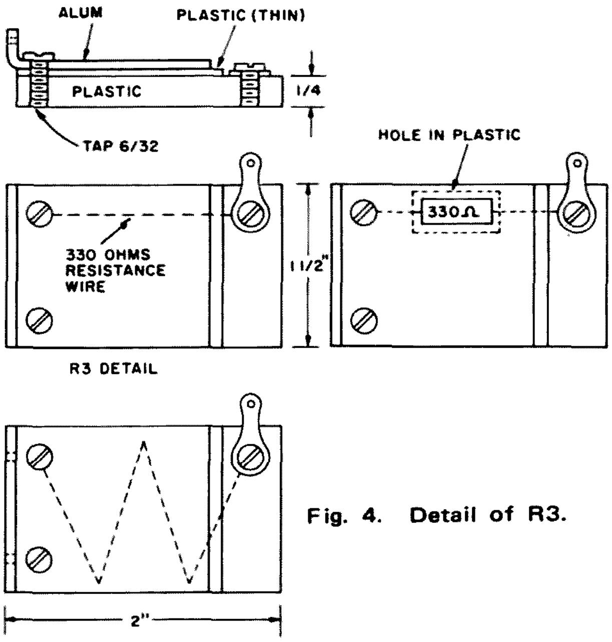


Fig. 4. Detail of R3.

This in turn was covered with a sheet of thin plastic to keep it clean.

Fig. 4 shows several ways to construct the resistor R3. I couldn't find resistance wire that would do the job so a ¼ watt 330 ohm resistor was installed into a tiny depression. This resistor is important. It keeps the bridge accurate over its frequency range, which is approximately 1 to 14 mhz. **Fig. 5** shows how the unknown connector is constructed. Use your imagination throughout. Use what you have. The resistor is soldered to the outside of the plug as shown.

Resistance Calibration

In the following discussion the word balance is used for the initial balancing of the bridge. The word null is used to designate the final balance.

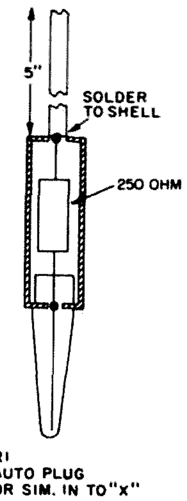


Fig. 5. Detail of R1 in its shield.

Connect a well shielded receiver to the detector terminal of the bridge and a signal generator low in harmonics to the generator terminal. Clip the unknown lead (the one with R1 inside) to ground. Set the signal generator to 1 mhz and tune the signal in on the detector. The signal may be modulated. Set the reactance and resistance dials to zero. Now secure the balance by using the balance capacitors. You should be able to make the signal disappear entirely. If you don't get the balance, check the wiring. Check for shorts in the transformer, the three reactance boxes or try changing the value of R2. Adding capacity to C2 will help balance the resistance dial if you are having trouble with it. Use 75 to 100 pf for

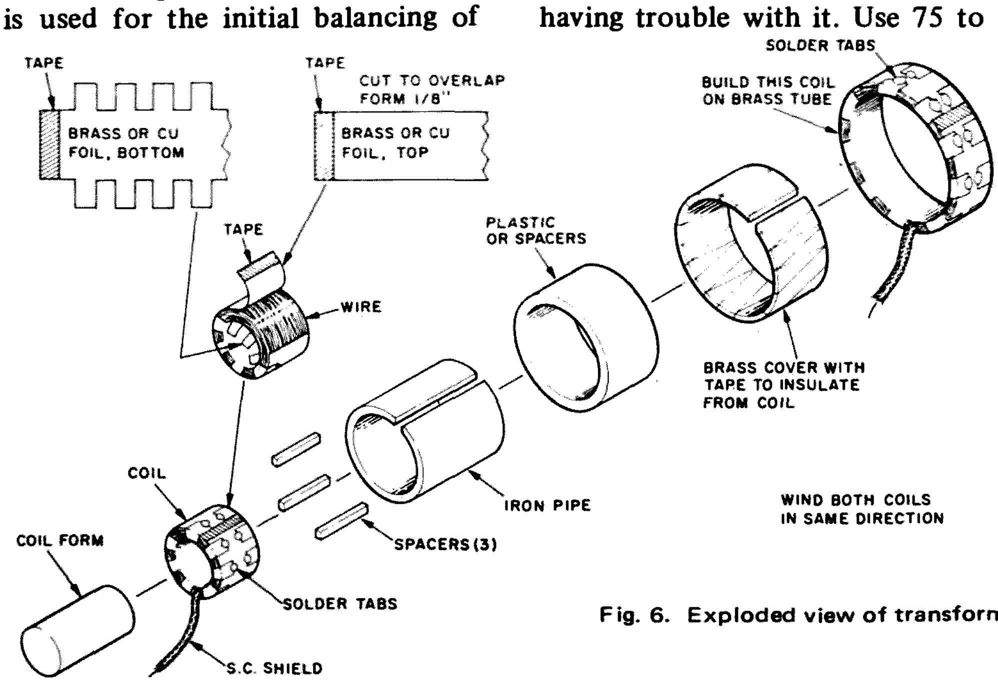
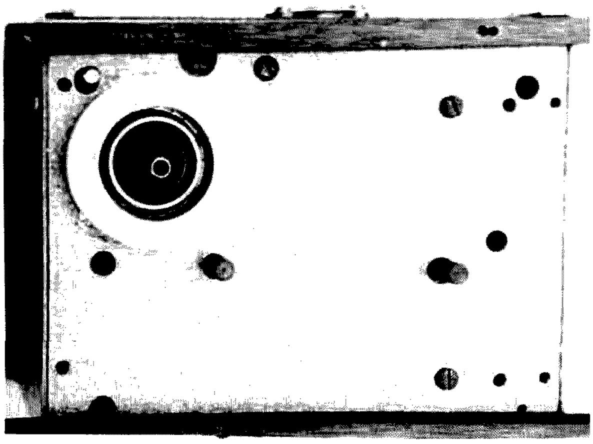


Fig. 6. Exploded view of transformer.

C2 and you won't have to use a trimmer like I did. Zero on the resistance dial C 1 is minimum capacity. Zero on the reactance dial C3 will be at maximum capacity. When a balance has been secured calibration can begin. Substitute a noninductive resistor in the unknown line and move the dial to the null. Mark the value of the resistor on the dial. Use progressively larger resistors until the dial is calibrated to your satisfaction. Some adjustment of the reactance dial may be necessary as you go up in resistance values because of the reactance of the resistors. This won't affect the accuracy of the resistance dial. The BKX bridge reads to 500 ohms. Yours may be slightly differenct according to the capacitors that you have used.



Reactance box looking down into the unknown terminal shielding and showing the insulated capacitor shafts.

Reactance calibration

Most of the calibrating can be done with a 1 μh 5% tolerance choke. J. W. Miller makes one (No. 4602) that sells for about 45 cents. A reactance chart is handy for checking your arithmetic. Most handbooks contain one.

Set the resistance and reactance dials to zero and balance. Insert the 1 uh choke in the unknown line and null. The resistance dial won't move much. The reactance dial will move upscale and at each point write in the reactance values according to the Table 1. This table has been worked out to slide rule accuracy and is close enough for our purpose. If you have a general coverage receiver an infinite number of calibration points can be found. In Table 1 the first column is used to calibrate the dial. The second is the frequency of measurement, and the third is the actual reactance of the choke at each frequency. Note that the last

DIAL READING	FREQ MHz	REACT
6.3	1	6.3
16	1.6	10
77	3.5	22
100	4.0	25
300	7.0	44
336	7.3	46
1200	14.0	88
1290	14.3	90
2760	21.0	132
2860	21.3	134
4930	28.0	176
5150	28.6	180
5640	30.0	188

TABLE 1
CHOKE 1 uH 5% TOL.
MILLER NO. 4602

two columns multiplied together equal the first column. If you use a different value of choke use the formula $X=2\pi fl$.

Calibration with capacitor

Insert a .005 Mfd capacitor in the unknown lead with the resistance and reactance dials at zero. Balance the bridge. Note that the first balance is with the capacitor. Now remove the capacitor and clip the unknown lead to ground. Null the bridge using the reactance dial. Mark the dial reactance according to Table 2. An .005 happens to be about 32 ohms. Calibrating the bridge with capacitors is a backward process; that is, the bridge is initially balanced with the capacitor in the unknown lead and then the unknown is grounded. There comes a time when a balance can no longer be secured. This is around 1000 ohms reactance. To calibrate the remainder of the dial you'll have to switch to an inductor. For capacitors other than those in Table 2, use the formula $X=1/2\pi fc$.

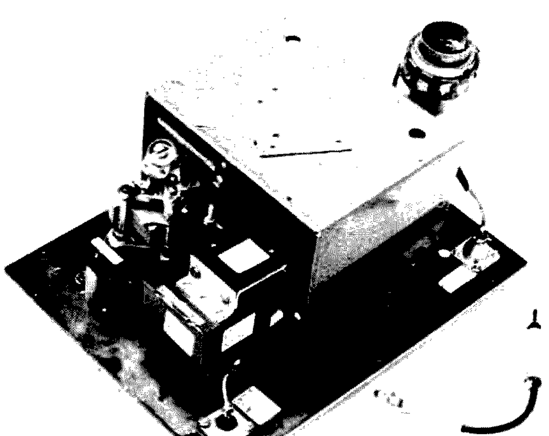
MFD CAP	RESIST OHMS
.005	32
.001	159
.0005	318
.00033	482
.00022	725

TABLE 2
READ AT 1 MHz

$$X_c = \frac{1}{2\pi FC}$$

Using the bridge

Now that the bridge is working and properly calibrated take a look at an antenna. First balance the bridge at the frequency of measurement. Next clip in the coaxial line, grounding the shield to the case. (The measurement of twin lead is very complicated and laborious and is beyond the scope of this article.) Swing the resistance dial to what you think the reading should be. At this point you will get a slight null. Now swing the reactance dial. If your antenna is inductively reactive, the null



Inside of bridge showing cans and construction.

should be quite sharp when you hit it. Touch up the resistance dial again and go back and forth between the two until you can no longer hear the signal. Don't forget to divide the reactance dial reading by the frequency in mhz that you are using. If you don't get a null with the reactance dial, the antenna is capacitive and the following method must be used.

Set the resistance dial and reactance dial to zero. Connect the antenna to the unknown terminal and balance. Remove the antenna and short the unknown terminal to ground. Null the bridge with the resistance and reactance dials. The new reading is capacitive reactance. Divide by frequency.

Here is another example of measurement of reactance when the sign is unknown. Let us measure a 50 ohm coaxial line at 14 mhz. Ground the shield of the antenna to the ground post on the panel. Plug in R1 and ground clip to panel. Set reactance dial to say 450 and balance the bridge. Set resistance dial to zero. Clip in the antenna and null with resistance and reactance dials. Suppose the new dial reading is 50 ohms resistive and 310 ohms reactive? Subtract the 310 ohms reactance from the 450 ohms reactance that you balanced with and the answer is 140 ohms capacitive. Divide by frequency of measurement. Fourteen mhz into 140 ohms reactance leaves 10 ohms, which is capacitive. Z-50-j10. If the reading of null moved up scale subtract the smaller number from the larger and divide by frequency to get the positive reactance.

The unknown lead with R1 may be made longer than 5". Usually two leads are supplied with a bridge. The shorter is used when practical.

. . . W6BKX

Photographs are by Ralph Parlette, WB6JOY.

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Religion, Politics or Sex

For the first time in 37 years as a licensed ham I have become incensed enough to write about a trend in operating practice. I want to say that I completely agree with those who feel politics, religion, and sex should not be discussed on the ham bands. Our frequencies are not assigned over to our use as an open forum. I thought it might be well to mention some of the things I discuss over the air, which bring me many QSLs stating that the other fellow has really enjoyed the contact with my station. Perhaps I am an old Fuddy Duddy, but I hope that there are some new comers who would like to become my kind of Fuddy Duddy and enjoy another facet of out art.

I am fortunate I know, in that I have been mobile in 49 of our 50 states. The XYL and I have never been to Hawaii, perhaps because they have never sold a Chevrolet automobile with pontoons. This gives me an edge for a first suggestion. Get yourself an Atlas of the United States. I suggest the Texaco Touring Atlas. The latest issue has a list of towns next to the maps of the various states and provinces. As soon as you get the other station's QTH, look for it in the Atlas, find his location and tell him you know where he is situated, then ask him some questions about his area. If you see a lake near him, ask about boating or fishing, in the case of a mountain, ask him if it is used for field day or other questions that come to mind. If you have been as fortunate as I, to have visited in his area, tell him so and try to recall what interested you when you were there. This map study will bring out something interesting in all but the most hardened introvert.

I think one question many hams ask, is what do you do for a living? Let us go one step further and ask what he does for recreation. It is usually more interesting to you, and certainly most of us feel we have more or less ordinary types of occupation, to be less apt to go into an interesting discussion about our work. If you should have an interesting and ever changing job, such as a traveling salesman working mobile, why not tell your contact about it?

There are other areas that can be used for conversation that will vary with the location of the station. I could make an outline for another operator to follow, but I will cover some of the things I discuss. Perhaps this is a deadly list of subjects to many hams, but from the enthusiastic response I have received, the contacts I have had certainly hide their boredom very well. I live in the state of Maine. Since many stations want Maine QSLs it is possible they will put up with a lot of silly chatter insure getting a card, but I don't like to think this is the case. You follow what I can say about my location, then sit down and write a list of things that you can talk about covering your state or area. It takes a little digging but it is worth it I am sure.

The home QTH is near Portland in southern Maine, which is a big state of almost 400 miles long by 275 miles wide at its widest point. I am actually closer, by a few miles, to New York City than I am to Fort Kent on the northern boundary of our state. Many contacts bring up the subject of cold weather and so are told that over the years I have watched the temperature in New York City and compared it to Portland official temperature which is seldom as much as 15 degrees colder. My guess would be that our average is a 10 to 12 degrees lower reading, but it is enough that in the winter we get snow, and keep it, so most winters' snow is with us all season and does

not disappear as it does even as close to us as Boston, 125 miles toward New York. In winter most contacts are interested in the snow removal operations we have here, and how quickly our driving returns to normal after a storm. The new popularity of snowmobiles for family winter outings, both at night and during weekends make interesting conversation. The other chap may think we are nuts to live in Maine, but he likes to hear about it and sit there in his warm shack shaking his head over such fools as we.

Much of Maine is timberland with little or no population. These wilderness areas make a good topic. Actually, the total population of our state is slightly less than Metropolitan Boston. Is it any wonder so many stations are looking for QSLs? This makes good talk with a W6 station about Sweepstakes Contest. All we have to do is shout "State of Maine" and there usually is a pile up on our frequency, for this reason we have a slight DX edge, over many of the other states. It makes me a little sad because a W6 is just California again! The operator in a rare state like Nevada, Idaho, Delaware, Wyoming, and many others, might be wise to get the habit of calling CQ and stating "here is Idaho calling", etc. These states might do better calling CQ than answering them. When I do call a station after he has made a CQ I always reply "W1DIS State of Maine" and I can often get the nod when my signals are down for they will come back asking for the Maine Station and they don't have my call. Discuss your operating habits and little tricks. Even an old dog can learn new stunts!

Because of location, Maine is a backward state in some ways. Our number one industry is the Pulp and Paper business. Number 2 in dollar income to the state is the vacation money spent here four seasons of the year. Bathing, boating and just vacationing in summer, hunting in the fall, skiing in winter, and fishing all year round is a drawing card for many. I have to be talking to a fairly sad sack if I can't get some response out of a statement on our vacation possibilities. I also live on Sebago Lake which has 47 square miles of water and is one of the largest lakes in New England. It is the home of the "Land Locked Salmon". A fisherman will really bite on this tidbit. Many years ago freight boats traveled through locks being lowered some 260 feet from Sebago Lake to tide water. In those years Atlantic Salmon came up into the lake to spawn, and when the locks were no longer used they could not return to the ocean and so now they go up little streams that feed Sebago Lake to spawn but with the help of the fish hatcheries run by the state, we have good Salmon fishing, as well as exporting Salmon eggs to other states. If I can get a few hams to come this way for vacation I help my state. I always ask them to write to our Maine Publicity Bureau to get information, and ask them to please mention that they got the idea from a radio ham which helps our image.

If the person you are talking to is likely to visit your area, suggest to him the best places to go that would be of interest. Here in Maine, I warn a prospective visitor that he will not see the real "rockbound coast of Maine" from U.S. Route 1, but will have to go down side roads, and mention the best ones to him. In this age of space travel, we have towns with stores that not only refuse to sell beer, but you can't buy cigarettes nor a Sunday paper. These people are not backward, they have their convictions and stick to them, which makes the "yankee" and interesting person. We always recommend that the new visitor eat some lobster while in Maine, and a discussion of the habits of this crustacean, how they are caught and handled live into market, make for an additional topic.

We live 70 miles by road from Mount Washington. This is the highest mountain in the United States east of the Mississippi River and north of the Carolinas. There is a television station, FM and commercial transmitters at the summit. It is said to have the worst weather in the world at the summit, and all power is developed by diesel engines using oil hauled by special trucks during the summer. The crews who man the station up there are changed each Wednesday by the use of a snow cat machine, if it can make the trip up the 6,288 foot high mountain. This road is available to motorists as a toll road in summer, and what a spot for mobile activity, especially on 50 and 144 mhz.

For those hams who might be interested

in history, we go back to the Civil War. I have said Maine is a backward state, and it all goes back to the fact that more men died in battle, in the biggest engagements of the Civil War, based on a population basis, from Maine, than any other state in the Union. The 20th Maine and other Maine groups were at Gettysburg and Chancellersville, as well as many other battles. The old idea of having all the men from one state fight as a unit was the problem. If that unit took heavy casualties, and the 20th Maine certainly did, then the state suffered. Many of the soldiers were farmers of the rocky soil of this state. Some were not casualties of the war but they heard of the wonderful land in the midwest and never returned home, but went west after mustering out of the army. As a result there were many widows in Maine from both situations, and as might be expected a drop in the birthrate, and no men to continue farming the farm land of the state. Maine has never fully recovered for even today stone walls show where fields once were, but are now wooded areas. In recent years the state has become attractive to retired people and younger persons who desire a less accelerated way of life. We have some of the best professional brains in the country living in Maine, because they are willing to take a smaller income, in trade for the assets in the recreation area in Maine.

This does not begin to cover all the subjects I have used during my QSOs. I am sure that almost any part of the country contains as many or more interesting items available for discussion. Just take a few minutes and think of the things that are commonplace to you, but would be of interest to a ham from another part of the country. If we are operators with so little imagination that to remove Politics, Religion, and Sex from our conversation would ruin our hobby, I wonder how we ever managed to master enough technical knowledge to get our ticket? Come on now, let's grow up and be adult!

...W1DIS

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VHF-FM: Part II

Mobile Installations

As stated earlier, 75% of all FM activity is operated from the mobile. Fortunately, mobile equipment is easiest to come by and is less expensive than a base station. Again, when you purchase these units, they come with all accessories–transmitter, receiver, power supply, control head, speaker, mike and cables.

Most two-meter rigs have to be converted from the adjacent 150-174 mhz Business Band down to the high end of 146 mhz. All this involves is maybe padding each of the receiver "front end" rf coils with a capacitor of good quality and possibly making a new final tank coil. As for 6-meters, the units have to be brought up from the 30-50 mhz Business Band to above 52 mhz. Depending upon where the rig was previously tuned, you may have to cut down some coils or perhaps change a few capacitors. The rigs that are to be put on "450" often need no modifications. In every case, however, the rig must be completely re-aligned and new crystals must be installed (more on this subject later). Converting narrow-band gear to wide or wide-band to narrow does get a bit more involved. The rigs are usually slightly scratched up and dusty (depending on age). However, some sandpaper and a can of spray paint can really do wonders. Any way you look at it, the rig itself will be in the trunk and the only things that you can see are the control head, mike, and speaker under the dash.

As for mobile power supplies, they come in three types: dynamotor, vibrator, and T-power* (transistorized). The dynamotor supplies are always found in the rigs from the 1952 to 1957 era, usually running to 60 watts. These dynamotors do waste a ferocious amount of power as compared with a vibrator. The price of the unit is less however. Vibrators provide a good compromise. They do not eat up as much power as a dynamotor and are not as expensive as a T-power rig. Vibrator supplies were most prevalent between 1952 and 1962. If you want to pay for the best, you can get T-power, but quite a few hams who want this feature modify the existing rig. The advantage of T-power is that it is the most efficient method and it lasts the longest. T-power rigs can be found from 1962 to date. The oldest rigs use 6 vdc only, with later rigs using 6 *or* 12 vdc and even later ones using 6 *and* 12 vdc. The newest rigs (still in production) tend to use 12 vdc only.

In receivers, the sensitivity is usually quite good–on the order of 1 μv to 0.5 μv for 20 db quieting without a preamp. If your particular receiver does not match this, a simple FET pre-amp will fix things up in a jiffy. Receivers such as the Motorola Sensicon "A" also have a "cavity front end."

With transmitters, the power rating is in *output* rather than *input*. Thus, you can compare a 60 watt commercial FM rig with a 120 watt amateur transmitter with 50% efficiency when measured for input. The moral is, don't let the 10 watt power rating on some of the cheaper rigs scare you away (i.e. Motorola FMTRU-41V \$35 up). By the way, many of these rigs are not really FM, but Phase Modulation. These two methods are received alike in the FM receiver, though.

As for makes of rigs, Motorola and G. E. are the two big names. For the beginner, perhaps these two are the best to start with because schematics and documentation are easy to come by. One more school of

*Reg. trademark of Motorola.

thought is that since these brands are the most popular, if you run into trouble, you can easily consult someone with a similar rig on your problem.

Mounting these rigs is somewhat unique. You have a choice of two methods. First, you can mount the whole rig under the dash. Second, you can mount the rig itself in the trunk with the supplied cables leading to the control head, speaker and mike under the dash. This way, the chance of theft is less, and the XYL gets her leg room. The latter is more popular and the price is usually the same.

If the rig was built before 1952, the chances are that the transmitter and receiver are separate cases. From then on, however, the transmitter and receiver are in the same case, but in modular form. Thus, if a unit went bad, the service technician would simply plug in a new transmitter, receiver, or power supply, "strip" and repair the old one.

Where do we obtain such equipment? Of course, if you want to get the best price, one of the "Hams Only" distributors is ideal. However, if you want a large selection, a commercial distributor is for you. With some companies, some equipment is sold as-is, but most companies have a short guarantee. Before you do anything, however, you had better write for a few catalogs to determine what you would expect to pay and become familiar with some of the rigs.

Here are a few such companies with catalogs:

Gregory Electronics Corp.
249 Rt. 46
Saddle Brook NJ 07662

Mann Communications
18669 Ventura Blvd. Tarzana CA 91356

Spectronics, Inc. (Hams Only)
1009 Garfield Street
Oak Park IL 60304

C & A Electronic Enterprises
2529 Carson Street
Long Beach CA 90810

Although this company does not publish a catalog, Newsome Electronics is a "Hams Only" distributor with competitive prices. See March 1969 ad in 73 Magazine.

When buying antennas for the mobile rig, it may be good to get what is called a "gain antenna." The familiar gutter clamp type antenna which is popular in some temporary installations (which figures out to be about 18.7 inches) let's say has a gain of "X." With the use of a "gain" antenna you have a 3 db gain over the 18.7" whip. Thus you can get 2X gain with the use of the "gain" antenna. Think about that . . . twice the power out (ERP) and twice the receiver gain just by using a different whip. You can get a small 18.7" antenna (commercially built) for about $6. A "gain" antenna will run anywhere from $16 to $27.

Now about one of the most important topics . . . prices. Prices will all vary according to age and condition of unit, transmitter power, type of power supply, manufacturer, and whether the unit is narrow-band or wide-band. Commercial dealers will always want more for narrow-band gear. Just because you paid twice the amount of an older unit for your later model, don't expect the newer one to be twice as good. The older unit may be dirtier and take up more power, but that's about it. . . . WB2AEB

The Umbrella Antenna

By building "out" instead of "up," a very efficient antenna requiring pole heights of only 10 to 20 feet can be built for use on the low frequency bands—40, 80 and 160 meters. No difficult or special construction or materials are required.

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Short vertical antennas for the low-frequency bands are certainly nothing new. Inductively loaded mobile whips are a common form. They take up very little space and perhaps for the mobile situation are the only practicable antenna form. However, considered for usage in a fixed station situation where even a moderate amount of space is available, it appears foolish to accept the limitations of such a form. The limitations of the loaded mobile whip—poor efficiency, very narrow bandwidth and an awkward value of terminal impedance—arise because of the form of loading used. A small loading coil is required because of space limitations and in order to provide even usable efficiency the coil must be of high "Q" with resultant narrow bandwidth.

If the space limitations did not exist, it would be desirable to make the loading coil as large as possible to increase efficiency. Also, it would be desirable to include some form of capacity or "top-hat" loading since the reactive effects of the inductive and capacitive loading will act to maintain antenna resonance over a greater bandwidth. It is rarely possible to do this in a mobile situation but it is possible in a fixed station situation. This article describes a form of antenna which combines a very efficient method of combined inductive and capacitive loading while still requiring very little space compared to any conventional antenna of full-size dimensions.

Umbrella Loading

The basic form of the umbrella antenna is shown in **Fig. 1 (A)**. The vertical mast is relatively short (10 feet on 40 meters, 20 feet on 80 and 160 meters) and the wire web on top introduces inductive loading by

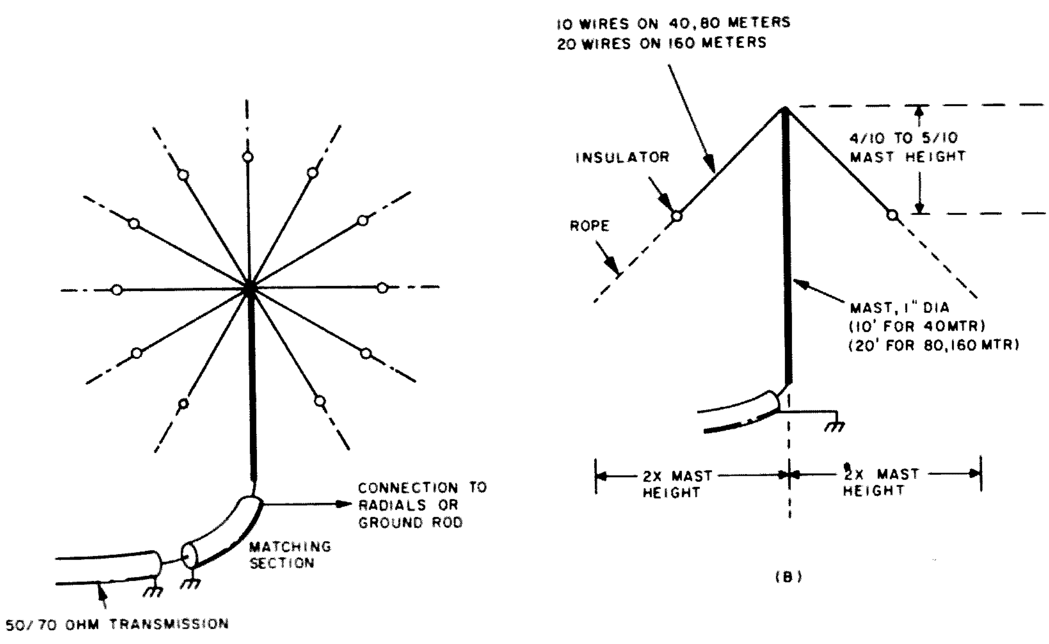

Fig. 1. Basic dimensions of the umbrella antenna.

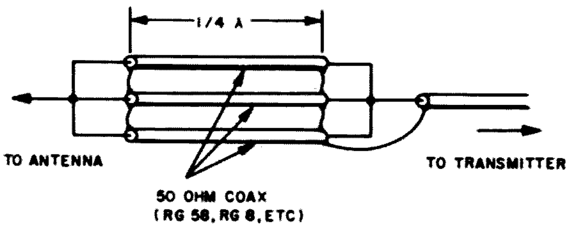

Fig. 2. Transmission line matching transformer for use between base of umbrella antenna and 50/70 ohm coax line.

linearly extending the length of the mast and capacitive loading due to the capacity effect between individual web wire and between the wires and the mast. A side view of the antenna is shown in **Fig. 1 (B)**. The dimensions shown were not randomly chosen as one might at first imagine. They are a compromise between a number of factors. If the web wires are brought closer to the mast, the effect of the loading is reduced. If the web wires are made more horizontal, the ground area required increases (however, the loading effect is increased and if the antenna is mounted on a structure such that a large area is available, this approach may be used.) The vertical projection of the web should be held to within ½ the height of the mast. Making the web wires longer will increase the loading effect but the radiation pattern will change such that high angle radiation results and the antenna does not perform as the equivalent of a full-length quarter wave vertical. If one does not object to the high angle radiation or, in fact, prefers it for short-medium distance work on the lower-frequency bands, the web wires can be made as long as desired.

The number of wires in the web will influence the resonant frequency as well as the feed point impedance of the antenna. Six is the minimum which should be used and probably 10 or 12 is a reasonable number considering loading and constructional complexity. Increased loading effect will take place up to at least 20 wires.

The feed point impedance is not as high as one is used to with a purely inductively loaded antenna. Because of the effect of the capacity loading, the feed point impedance when a good ground connection is used will vary between 5 and 8 ohms. Any one of the conventional methods used to match a low impedance load—such as the driver element on a multi-element parasitic beam—to a coaxial cable may be used and so they will not be shown here. One slightly different method to match the antenna by means of a quarter-wave transmission line transformer is shown in **Fig. 2**. Three lengths of coaxial cable are paralleled. to form the required simulated low impedance transformer section.

Construction

The main vertical section of the antenna was made from a standard 10 foot aluminum TV mast. The mast was mounted to a ground stake by two standoff insulators (Birnbach No. 448 pillars with tube clamps at each end). A home-brew standoff can be easily fabricated from a block of wood or polystyrene and cutting a hole at both ends for insertion of two adjustable hose clamps. Since the base is at a low voltage point, the quality of the insulator used is not critical.

The ten wires comprising the top web were fastened to the mast by means of an ordinary ground lug. Hook-up wire was used to construct the web although it is suggested that stronger wire be used—common TV guy wire would be an excellent choice, for example, for rugged installation.

As with any antenna being worked against ground—be it full-size or a loaded type—the quality of the ground plane has an important effect upon antenna performance. In moist soil a ground rod driven several feet into the ground may suffice but otherwise a cluster of 10 to 12 radials buried several inches and extending at least to the point where the extension of the web wires touches ground is very desirable.

The author's antenna was constructed following the outline dimensions given in **Fig. 1 (B)** to resonate on 40 meters. After installation and testing it was found that resonance was very slightly below 40 meters. The situation was corrected by placing the ground terminal for the web wires slightly closer to the mast. This was done experimentally while checking the transmission line SWR. There are several variables involved in determining the exact resonance of the antenna and either one can vary the angle of the web wires to "fine-tune" the antenna or these wires can be firmly placed on either a small inductor or capacitor used

at the base of the antenna for final adjustment.

Summary

Antenna efficiency is at best a difficult thing to measure or estimate even under the most ideal conditions on low-frequency bands. Compared to full-size quarter-wave verticals, the best estimate is that the umbrella antenna is from 60 to 70% as efficient. This is certainly a far cry from the usual loaded mobile whip which has efficiencies of 2-5% (100 watts transmitter output, 2 to 5 watts actually radiated).

The bandwidth depends upon the band for which it is constructed. On 40 meters when resonance is adjusted for 7150 kc, the antenna will satisfactorily cover both the CW and phone band edges with an SWR of from 2:1 to 2.5:1. On 80 meters either the entire phone band can be covered or the CW portion; the bandwidth is about 250 kc overall. No tests were made on 160 meters but the coverage should be in the order of 75 to 90 kc which is certainly adequate for most uses on that band.

If the antenna is constructed for 40 meters, a double resonance will be found to occur on 21 mc—the same as for any monopole or dipole operated on odd multiple harmonic frequencies. The antenna should be quite efficient on 3rd harmonic operation but the problem is one of the resultant radiation pattern. The pattern appears to produce mostly high-angle radiation which, of course, is useless for DX purposes. Nonetheless the antenna may still be useful as an auxiliary antenna on this band.

The umbrella antenna appears at first glance to be a rather simple and elemental type of loaded antenna. Actually, it is not when one considers its advantages in terms of preserving a low radiation angle and achieving quite good efficiency—all within reasonable dimensions. This form of antenna may not allow an apartment dweller to put out a booming signal on 80 meters but it should certainly permit someone with a moderate amount of space to considerably improve his signal on any low-frequency band as compared to using a whip or randomly placed and tuned length of wire.

... W2EEY/1

Solid State 432'er Transmitter Part I

Bill Hoisington K1CLL
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Peterborough NH 03458

Since it is straightforward, why not take advantage of our solid state 432'er? It offers, 1) low cost vhf "plastic" transistors selling for less than $1.60 each, 2) a 12 volt dc power supply for home, mobile and portable use, 3) highly dependable circuitry, 4) small size without sacrifice in operation, 5) will fit inside a small shielded box, and 6) can be used as an exciter for higher power.

If these five points do not satisfy you, you're hard to please. To get to 432 mhz becomes a problem which can be accomplished by both doubling and tripling. You can use a 54 mhz crystal, double to 108, 216, and finally to 432 mhz. Another way uses a 48 mhz rock, triples to 144, then triples again to 432 mhz. If this tripler method causes you to add another stage as an rf amplifier later, you haven't gained much. We'll see how it works out.

Trouble

If my trials and tribulations save you time, that's okay by me, as of course I encountered them right away. Refer to **Fig. 1**, the main schematic for the following, and also **Fig. 2**, layout. As usual when something real bad shows up, it is often caused by more than one thing. This time, out of more than 20 crystals here between 45 and 54 mhz, I picked a poor one. The oscillator coil was no good and also L1 and C1 were too high in frequency. A quick check on all the crystals in the shack showed three "fair" and the rest

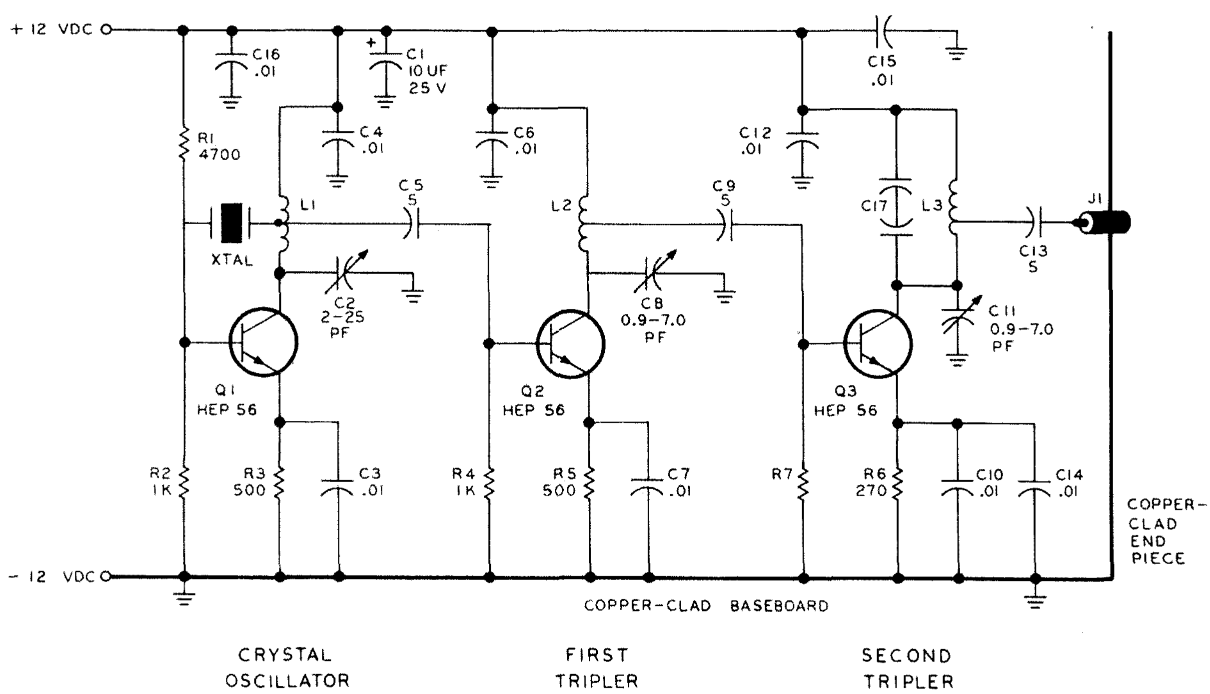


Fig. 1. Main schematic. C1–Arco-421; C8–Arco-400; L1–15 turns no. 26 on 3/16" o.d. form, center tapped; L2–8 turns no. 22, on 3/16" form, center tapped; L3–3 turns no. 20 tinned bus wire, air-wound, 3/6" diameter, 3/8" long, with 1/4" leads on each end. Tapped one turn from ground end.

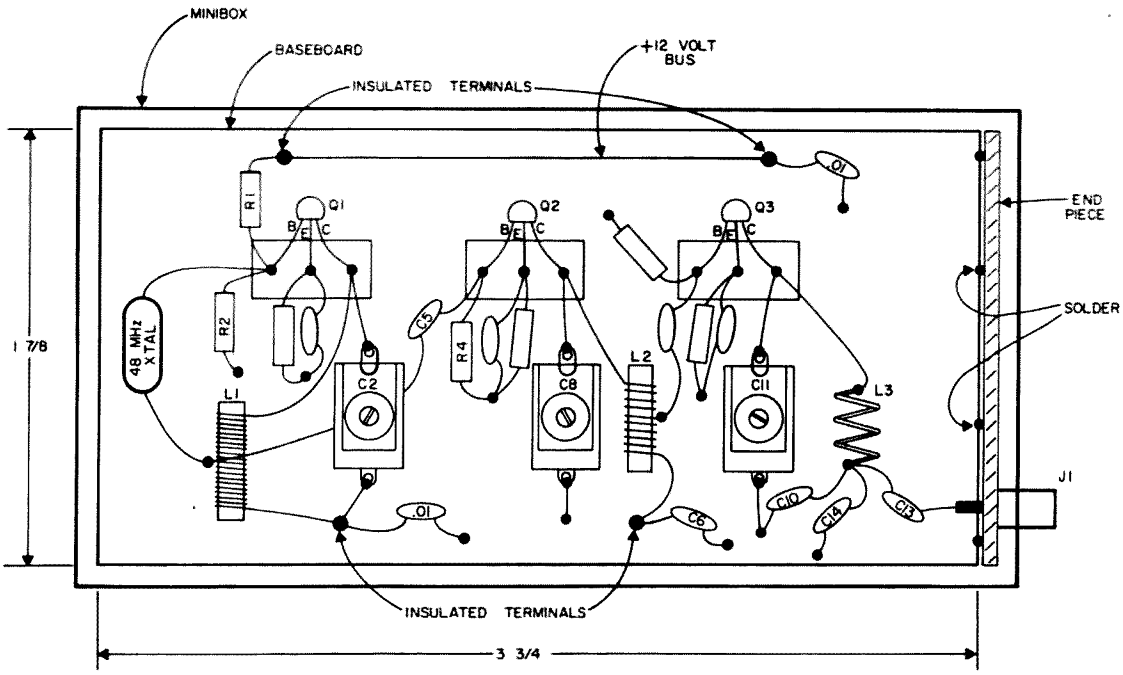


Fig. 2. Layout. This is not a complete schematic. Some wires have been left out for clarity.

good, with the worst being the only 48 mhz one in the lot. So I had to order some more pronto.

Changing L1 to a well-known airwound coil of 16 turns to the inch, ½ inch diameter, and making C1 a good variable 100 pf with an insulated shaft and a knob, I found 48 mhz and everything came back to normal.

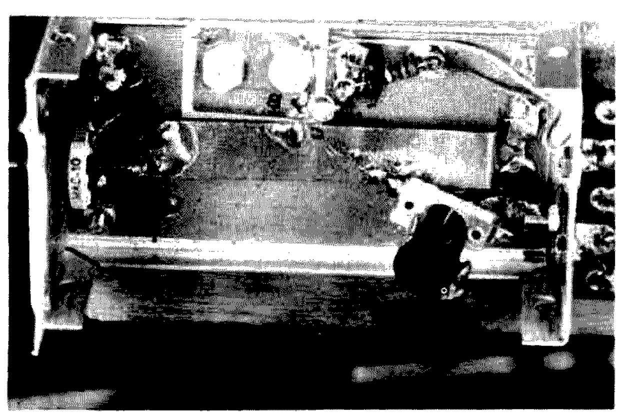
The perfect oscillator

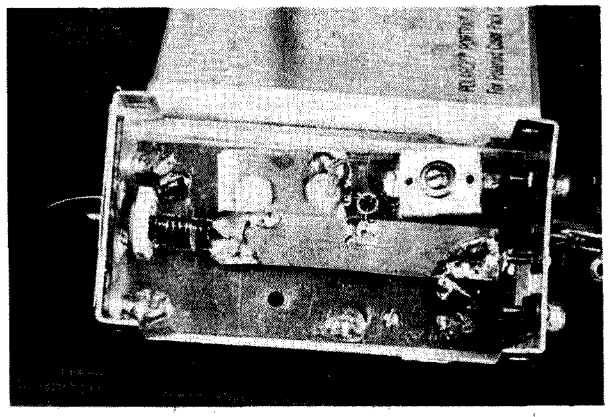
In the proper condition with a good crystal, the perfect oscillator works as follows. With the 100 pf variable capacitor, oscillation will occur when L1 is tuned to 48 mhz, as can be seen on the dc output meter with a tuned circuit for a frequency check. Also, I check with my lab receiver, at present an Ameco R5 .5 to 54 mhz, by listening to the carrier itself *without* the bfo, and with plenty of audio. This way you can hear small spurious rf clicks, etc., as they develop and when they occur. With everything working properly, even tuning C1 does not shift the carrier out of the receiver band pass of some 10 khz.

As you approach maximum power output by reducing C1, a point will be reached where it stops oscillation. Do *not* operate on this point. Back off a ways beyond the maximum power output point, making sure it comes on the air immediately with the battery switch every time. With a little listening as well as watching the output meter you will get the feel of it and have confidence in it. After all, a transmitter (today at least) no matter how big, has to start with an oscillator so it had better be good.

Phase-reversing crystal circuit

Please note that this is my long-time favorite circuit in which the degenerative, or negative feedback connection is used, which only becomes positive at the crystal frequency. The regenerative circuit (not this one) with the base on the other end of L1 from the collector and 180° out of phase, uses positive feedback all the time and is very critical as to just the right amount of feedback, and is liable to take off at a moment's notice on other frequencies under





the influence of slight changes. A crystal operates by changing polarity at its resonant frequency, thus one side of it (one connection) is always 180° out of phase with the other side. When on frequency this puts the base out of phase with the collector, which of course is the proper condition for oscillation.

Coils LI, L2, and L3 are small, so this exciter will fit into a 2 inch by 4 inch minibox (it did, and room for batteries as well).

LI was wound up on a 5/32 O.D. phenolic form with no. 38 wire just to check on the influence of small wire at 50 mhz in an actual oscillator circuit. It worked just as well as the airwound coil.

Small Components

This 432 mhz exciter in a 2 inch by 4 inch box with batteries is an example of what can be done at low cost by almost any amateur with a good pencil type soldering iron, (I recommend American Beauty. Have one of them running for almost ten years now and it hasn't burnt out yet.) tweezers, and today's small components.

The low cost "plastics"

Motorola has come out with a line of semiconductor products labelled "HEP", for Hobbyist, Experimenter, Professional. Included in this line of low cost goodies is the HEP 56, which so far answers my search for a "universal" transistor for general amateur use up through vhf and uhf. In my work with it, starting with a 48 mhz rock, it triples to 144 and up to 432 mhz like a bird, and puts out a good solid, stable signal.

Small resistors

Tenth watt resistors are listed by mail order houses so you can get those without trouble. The crystal oscillator stage emitter resistor has about a volt at 5 to 10 milliamps across it, which even by my pre-computer age arithmetic, is still only one hundredth of a watt. I used a selection of tenth watt Allen-Bradleys over 12 years ago when building subminiature tube (remember?) transmitters and to look at those little tiny things that they are, you wonder how they hold up, but every one of them still checks out within the rated tolerance of their listed value. And they all work well in other respects also.

Small capacitors

Lafayette still holds the field here, for my money. Granted, they're "imported," but isn't it one of our business creeds to see that "other people" import *our* goods? Anyway, they work. A .001 bypass is 1/8 inch square. And being small as they are they work at 432 mhz, which is more than you say for a lot of others. They must be soldered with TLC though, and the temperature specs read

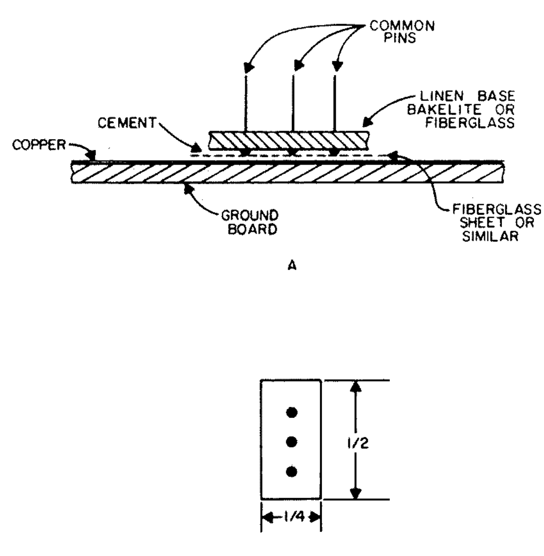
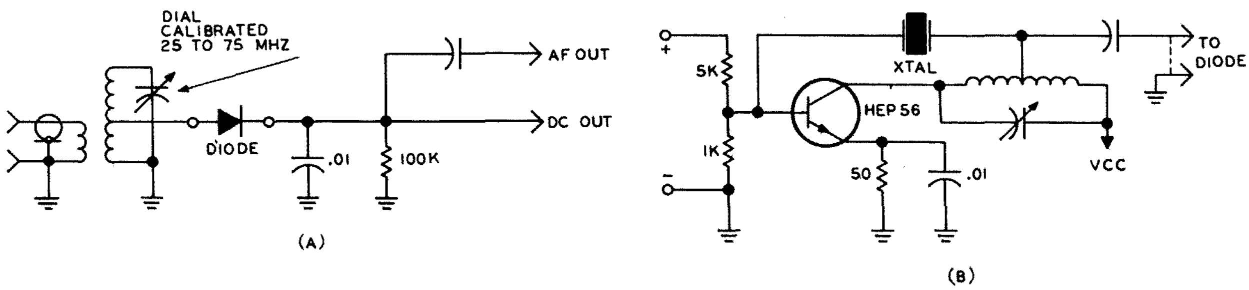


Fig. 3. Homebrew sub-miniature terminals.

"minus zero, plus 100%" which means they may increase capacity like mad on a hot summer's day, but who cares for a bypass? Just so they don't *drop* in capacity. They are made with a magic formula called "High K" whose dielectric constant may be several



Figs. 4A and 4B. Diode checker and oscillator.

thousand that of air (fresh air, that is—no L.A. smog).
stant may be several thousands that of air

For coupling use at rf, the small dipped micas are good, but again not as small as I'd like to see. Mica compression trimmers are not really small enough either but I'm working on that one. I don't like the ceramic rotary ones simply because you can't tell where you are with them. If they would only include a simple printed dial on them, be it ever so small!

Inductors

No trouble here. Nothing over 5/16ths diameter is needed, and they all tune up fine.

Sockets and/or terminals pins

This is a tough one. I make my own out of common pins, (seeFig. 3) and small pieces of bakelite or fiberglass. Drill an .020 hole, hammer in a common pin of diameter .021 and you've got one terminal. The layout, Fig. 2, shows how this makes things easy for you, especially with a copper-clad base-board.

Small transistors

The HEP 56 transistors mentioned are small of course, being only .185 inches high, which is still less than three sixteenths of an inch. They have good strong leads, and every one so far works well at 432 mhz. I can't see much else in that little minibox. Crystals can be had about ¼ inch square, at more money of course, but there was room in the box for a "monster" all of 3/4 inch high which I used because I had it.

Diode noise

It is of great importance when you tune up this multiplier or any multiplier for that matter, to be able to listen to the carrier from each stage as you build, or to uncouple the stages and check each, one at a time at its frequency, for noise, spurious radiation, etc. **Figs.** 4A and 4**B** show the diode checker and oscillator being tested. Use sufficient af amplification to show up "rf jumps," hiss, tendency to squeal, tuning clicks, and other signs of instability or non-smooth tuning. I sometimes use a scope also as then you can look, listen, and measure, all at once. It was while doing just this that I discovered that some diodes are very noisy under rf. I don't mean the noise figure on small signals, I mean that with several volts of rf some diodes at different vhf or uhf frequencies show a lot of noise that you might very well attribute to the stage or oscillator being tested. This is just what I did myself, losing more than half a day on the deal, until finally I tested a dozen or so different diodes here and found only two or three out of ten that do *not* show noise, one of them being my old favorite the 1N295. This one will put out 5 volts of dc, and still be absolutely quiet, either on 144 or 432 mhz. Of course, running lots of af in this fashion, you can hear plenty of action when you touch parts of the rf stages. After all, you're making up the rf carrier for your future rig. Do you want it to be noisy even before you modulate it?

Crystal oscillator

To start with, I see no reason at this time for a vfo on 432 mhz for normal operation. You can order a couple of spare crystals later, a little further up in the band in case of a band opening when the "big lads" would probably swamp you out, and that should be about it. After building this stage as shown, I hooked the diode tester to the output capacitor C5, and tuned it up as detailed in previous paragraphs. The layout,

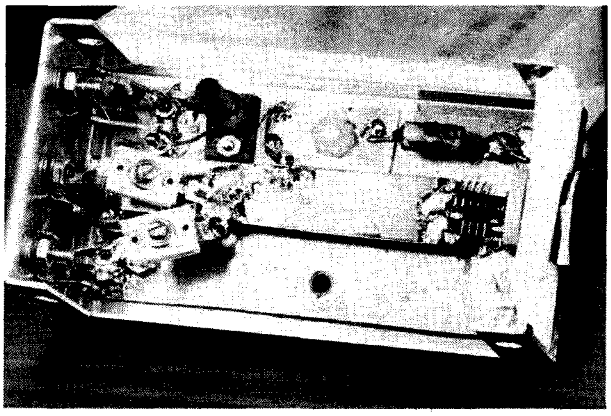


Fig. 2 should help also. I was surprised at what a neat package the whole thing turned into, with plenty of room everywhere.

Coupling circuits

A center tap on LI and L2, plus the proper values of capacitors for C5 and C9 does the job.

Be sure and listen to the output for noise. I have heard $400 to $600 SSB exciters that sounded like a freight train running before any modulation was applied. The output coupling capacitor needs a little more attention.

First tripler

Another HEP 56 was installed and showed good tripling energy power out on 144 mhz. A little roughness or tendency to jump a bit with tuning was encountered using a choke coil from base to ground, so a resistor of IK, R4, was put in its place, no loss of power was noticed, and the operation under tuning showed no spurious or jumping of any kind, just a nice clean smooth resonance curve with C2 and plenty of signal power output. A good three volts on the tuned diode circuit was obtained at 144 mhz.

The emitter resistor was adjusted to its final value for use in this tripler stage. Don't forget that for different harmonics, different bias values will generally be needed.

Milliamps will run between three and five for this stage, depending on the transistor used, and how hard you push it.

Second tripler

The third HEP 56 was wired up and it developed 432 mhz energy almost immediately. I had decided to try a completely conventional coil and capacitor circuit with these small components and it paid off, as you can see in the schematic, Fig. 1. Adjust the output tap on L3 and the capacitor value of C13 for the best match to your cable and load. In this unit the tap worked best at about one turn from the ground end.

Between one and two volts of rf at 432 mhz was obtained in the diode test circuit. This has gone 25 miles in the past, but the unit is really just an exciter. Two batteries and a battery switch were wired into the minibox cover just for show. See **Fig. 5**.

Collectors with **DC** ground

Just in case you were wondering why I didn't use that method here, after much success in receivers, rf stages, etc., I'll have to confess. I did use it here, in fact I built the whole three stage exciter using dc grounded collectors, and ran into uncontrollable noise, spurious radiation, and feedback. The final circuit on Fig. 1 with collectors off ground operates so smoothly and trouble free that no comparison is possible.

Overall results

Putting the minibox cover on, with batteries and switch installed in it (see **Fig. 5**), no trouble occurred. A cable over to the diode checker tuned to 432 mhz showed good rf voltage, and a dipole plugged in radiated. As mentioned, you can work out with this, but let's put at least one rf amplifier after it before modulating. Of course, all kinds of ideas can be generated here, like putting it in a long minibox with rf amplifier, modulator, plug in a beam antenna, etc.

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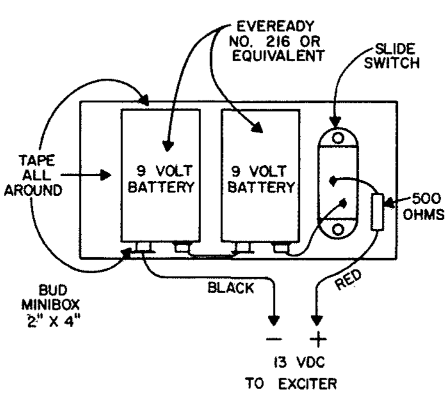

Fig. 5. Batteries and switch in minibox cover.

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Fascinating Fundamentals I: Electrostatics

No one can really say who the discoverer of electricity was. Long before the birth of Christ, the Greeks were aware of the mysterious properties of Amber. Amber is a glass-like clear yellow substance. Once the resin of ancient pines, it has been slowly petrified by the ages. The early peoples noticed that, when briskly rubbed, a piece of amber would draw tiny bits of hair and dust. As if hurled by some unseen force, they would suddenly leap up and cling to the amber. Then, just as suddenly, they would fly away.

For centuries, this phenomenom remained a petty curiosity. Then, as the knowledge of mankind advanced, it was destined to be the key to man's most miraculous achievements. The Greeks called amber ELEKTRON. From this modest beginning comes electricity, electronics, and the name of the real culprit, the electron.

We know today that the electron is that tiny bit of stuff that orbits around the nucleus of an atom, but this was far too advanced for the early pioneers of electrical science. Hampered as they were by fear and superstition, their progress was painfully slow. For example, one of the earliest observers of the properties of amber was Roger Bacon (born 1214). Although he was at first encouraged by an enlightened pope, he was eventually branded as a blasphemer and cast into prison. He came out in 1292, an old man.

Bacon's observations were the first really clear ones. But it was not until 1600 or so that William Gilbert, a private physician to Queen Elizabeth I, began to introduce some light on the matter. Gilbert discovered that many substances showed these properties. He called them "electrics." The force he called "vis electrica." He even made a crude instrument for measuring the electrical attraction—the "versorium." His work was widely published, and drew praise from the great Galileo.

None of these early pioneers, however, could understand or discover the reasons for the phenomena they observed. They had no precedents to refer back to, and even the best of their tools were clumsy by our standards. They had to grope their way along. We are fortunate in that we can back-track on the trails of progress and examine their discoveries in the light of modern knowledge.

The secret lies hidden within the tiniest of particles—the atom. An atom is itself composed of particles—particles of energy. The most readily accessible of these is the electron, the work-horse of electricity.

An atom is made of three kinds of primary particles: protons, neutrons, and electrons. The inner part consists of protons and neutrons, while the electrons revolve around this nucleus like planets around the sun. Of these three particles, only protons and electrons are of electrical importance, electrons primarily.

Let's try a simple experiment. Take a glass rod, and rub it briskly with a piece of silk. Now hold it close to a few splinters. The splinters will leap up to the glass, cling to it for a few moments, then fly away.

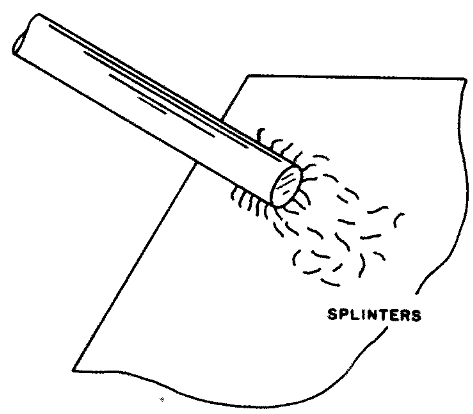

Fig. 1. Glass picks up splinters

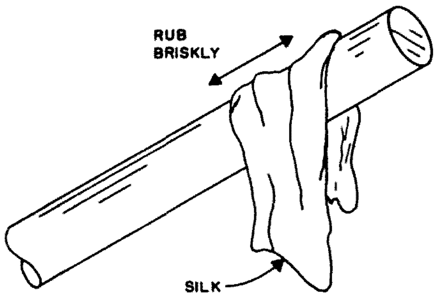

Fig. 2. Electrons are wiped off the glass.

When you rubbed the glass, you actually wiped electrons off the atoms on the surface. (When there is a shortage of electrons, we call it a POSITIVE charge.) Any electrically charged body will attract uncharged particles. As the splinters clung to the glass, it drew electrons away from them. Soon they also had a positive charge. Two objects with the same electrical charge will repel, or push each other away.

Take a piece of hard rubber and rub it briskly with a piece of wool or simply draw a hard rubber comb through your hair. This rubs electrons onto the rubber, making a NEGATIVE charge. A toy balloon rubbed on your shirt sleeve will stick to the wall, because it becomes charged.

There are a great many materials which you can charge by rubbing. A piece of paper will cling to the wall after being rubbed with a wooden stick. Your clothing, rubbing against the seat of a chair, or an auto seat will generate enough electricity to give you a snappy shock!

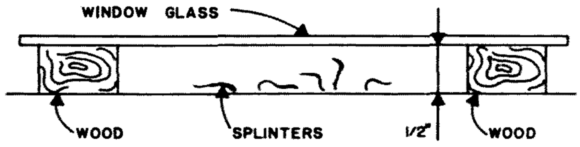

Fig. 3. Wipe the glass and watch the splinters dance.

Here is an easy-to-make demonstration. Sprinkle a few splinters on a table-top. Place a piece of glass about ½inch over them. Wipe the glass briskly with a silk cloth, and watch the splinters dance! This works best on a dry day; the dryer, the better. On a rainy day it may not work at all.

. . . W2FEZ

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Apollo TV & Radio

The television camera used on the lunar surface during Apollo 11 and also on the Apollo manned flights prior to Apollo 10, was a black and white (monochrome) RCA slow-scan camera with a 320 line horizontal, 10 frame per second vertical format. The color television camera used in the Command Module of Apollo 11 and Apollo 10 was a three-color wheel Westinghouse camera with a commercial format of 525 lines and 30 frames per second. The three colors are transmitted sequentially, recorded at the site of the deep space antennas, and sent without delay by commercial microwave networks to Houston. At Houston the three colors are converted to commercial mode, or dot-sequential, and released to the commercial broadcasting networks. On Apollo 10 and Apollo 11 the video signal was frequency modulated onto a 2272.5 mhz carrier from the Command Module. During the television transmissions no other signal was multiplexed on this particular carrier. However, the Command Module had another S-band carrier at 2287.5 which was frequency modulated with voice and telemetry, on sub-carriers at 1.25 and 1.024 mhz respectively. In addition, the psuedo-random noise code used for ranging was also multiplexed directly on the 2287.5 mhz carrier. The frequency for the seismometer left by Apollo 11 is 2276.5 mhz. The seismometer frequencies for Apollos 12, 13, and 14 are 2278.5, 2275.5 and 2278.5 respectively. To receive any of these frequencies, you would require a very sensitive receiver, and an antenna with a gain on the order of plus 44 db. There are a few companies which manufacture suitable microwave gear and at prices beginning at a few hundred dollars. The transmitting antenna for the Command Module on Apollos 10 and 11 was located on the Service Module and its forward gain is about plus 27 db. (This antenna was referred to as "the high gain antenna.") The lunar module of Apollo 11 utilized a third S-band frequency with the erectable parabolic reflector placed on the lunar surface. This portable antenna has a forward gain of plus 32 db and was used throughout the exploration. Both the RCA camera left on the moon and the portable antenna, as well as other equipment, are scheduled for further use in future missions to the first lunar landing site.

In addition to the unified S-band system, a VHF system can be used alternatively, and the VHF system of Apollo 11 provided voice communications between Armstrong and Aldrin, and between the lunar module and the command module. The VHF system is redundant to the S-band system, and the lunar TV, audio, and bio-medical data could have been transmitted directly on VHF to earth. Two VHF frequencies were provided at 259.7 mhz and 296.8 mhz. The 296.8 mhz frequency was used for voice communi-

cations between Armstrong and Aldrin, and between the lunar module and Mike Collins in the Command Module. In the Command Module of Apollo 10 and Apollo 11 is a second redundant audio-only transceiver, referred to as the "high frequency" system, and the operating frequency was just above WWV, at 10.006 mhz. In the Service Module, a recovery beacon operates during splash-down on a frequency of 243 mhz. (Note: The mixer-diodes used in commercial UHF-TV work well at these VHF-UHF frequencies.) A Sylvania "walkie-talkie" is also included in the service module to aid in recovery and to provide communications between the recovery vessels and the astronauts.

The types of emmission for audio is mostly FM, although communications between the lunar module and the Command Module was AM during Apollos 10 and 11. The types of emmission for telemetry include a variety of PAM/FM/FM, PCM/FM, SS/FM, SF/FM, on twenty-six channels. When television is not on, tele metry is multiplexed on the various S-band frequencies. When the telemetry is used on VHF, the frequencies used fall between 226.2 and 258.5 mhz, with one microwave channel in the Instrument Unit (used during launch only) on 2277.5 mhz. Other specific VHF frequencies used on Apollos 10 and 11 include 230.9 and 237.8 mhz for the Command Module, 247.3, 257.3, and 228.2 mhz for the lunar module. In only the lunar module, an altimeter was provided which operated on the X-band. A backup unified S-band system included frequencies of 2101.8 mhz (to the lunar module), 2282.5 mhz (which was used on Apollo 11) (from the lunar module), and 2282.5 mhz (used from the Command Module), and 2106.4 (to the Command Module). The average speed of the telemetry data is about 1200 bits per second, although the stations at Goldstone, California, Cape Kennedy, Florida, and Houston, Texas, have no upper speed limit. During Apollo 11, the huge dishes at Goldstone, California, were used at all possible times, although a massive global communications network (NASCOM) provides constant communications regardless of the tangent or orientation of the earth. The global network communications myrad is centralized at the Goddard Space Flight Center at Green Belt, Maryland. The relay frequencies include many which can be received on ordinary general coverage receivers with telemetry having frequency precedence. (These frequencies can be obtained by writing the Goddard Space Flight Center.) . . .W1FJE-TV

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The Receiver –

The Overlooked Piece of Test Equipment

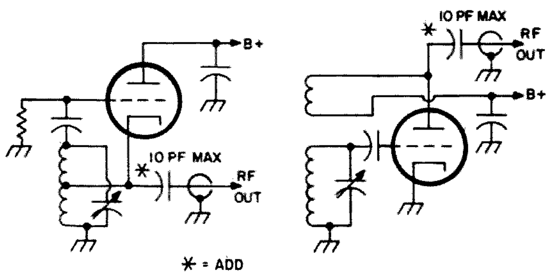
Mention test equipment, and the usual picture of a bench loaded with scopes, meters, tube checkers and various other equipment comes to mind–rarely does one find a receiver used as a standard piece of test gear. For many years the common receiver has been overlooked as a valuable addition to any test bench.

Recently I acquired a RBM-4 surplus Navy receiver after a round of trading. Having a SB-300, a NC-183 and various other special purpose receivers and transceivers, I was hard pressed to find a spot for the old workhorse. It eventually wound up on the test bench and it wasn't long before I realized its worth as a versatile piece of test gear. Besides the usual uses of a receiver-converter alignment, VFO alignment, checking for parasitics and harmonics–there are many other uses it can be put to on your work-bench.

Signal Generator

The receiver can be used as an excellent signal generator. Just couple lightly into the local oscillator and install a BNC connector on the front panel and you are in business. To read the frequency, all you have to do is read the frequency of the band in question and subtract the *if* frequency from it.

Some receivers have the local oscillator operating on the high side of the received frequency; in this case add the *if* to the received frequency to find the frequency of the local oscillator. With a general coverage receiver you will get enough range to cover most of your alignment needs. The receiver should be recalibrated after this modification, since the original calibration may be



COUPLING FOR USE AS A SIGNAL GENERATOR

affected by the added components. Also remember any load placed on the *rf* output will cause a small change in frequency. In any case the signal will be as stable and accurate as many of the medium priced signal generators on the market.

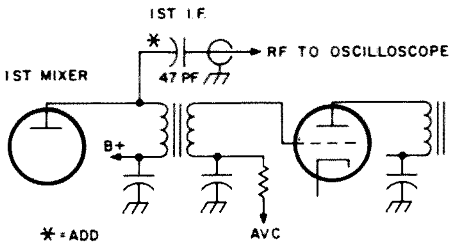
General Purpose Audio Amplifier

The audio amplifier may be coupled in to provide your workbench with a general purpose audio amplifier. This is an easy modification. Install a switch on the front panel which will either select the output from the detector or the input of a phono or similar jack installed on the rear apron of the receiver. Many older receivers have provisions for playing a record player through the receiver amplifier. In this case you are already set.

Modulation Monitoring

In addition to being able to listen to a signal being received, it is possible to get a visual presentation of the signal on your oscilloscope. You can monitor your own signal as well as those of others without any direct connection to the transmitter being

monitored. This is accomplished by coupling the vertical input of your scope to the first *if* transformer with a 47 pf capacitor.



USING THE RECEIVER FOR MODULATION MONITORING

Use shielded wire between the oscilloscope and the receiver. Realign the *if* stage in question, and you are ready to go. Be sure that your scope's vertical amplifier is effective at the *if* frequency! Another word of caution—while this is a very effective means of monitoring, several things must be remembered. Distortion may be introduced by the *if* itself. Few *if's* are completely linear; the avc will introduce some distortion too. The signal may be strong enough to overload the *if* stage. All of this can cause a false reading, so before you tell someone his signal has imperfections, make sure it is not at your end.

Audio Oscillator

If you need a quick source of audio, the receiver will again come to your rescue. Simply beat the bfo against the harmonic of a crystal calibrator. If one is not built in, use the output of your signal generator. If the receiver dial has 1 khz increments, you can get within a few hundred cycles of the frequency you want. Unfortunately the upper frequency limit is limited by the passband of the *if* and the audio stages. You should be able to get up to several khz with most receivers.

Many hams have old standby receivers that will not quite fill the requirements of today's crowded ham and swl bands. They have been relegated to gather dust on shelves, and now is the time to put them to work for you again. The number of things that can be done with one appears to be limitless. It all depends on what you need and what you have. The old adage "necessity is the mother of invention" certainly holds its own in this case.

. . . K1ZJH

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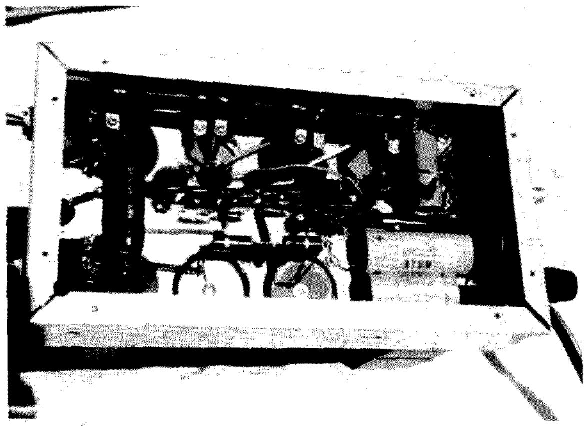
A Voltage Sextupler Power Supply

(Or, How to Get 900 Volts without a Power Transformer)

In a recent article in 73 Magazine, I described a transformerless ½ wave voltage quadrupler transceiver power supply, operating directly from the 117 volt ac line, delivering 600 volts high voltage, low voltage and bias. Since the article was published considerable comment has been received from readers. I might add that 100% of the comments were in favor of such a supply, due to the many advantages of the transformerless, voltage multiplier type. Typical comments were,"That's a FB power supply, Johnny, and I like the idea of no power transformer, but my brand of transceiver calls for 800 volts, and your quadrupler only supplies 600 volts dc. Isn't there a way to use the same idea and give more high voltage?" The answer to the question is affirmative, and it takes the form of a voltage sextupler, which multiplies the input voltage by six. The circuit is an extension of the modified quadrupler. Actually the resultant output voltage is more than six times the input voltage, about 7.5, because the capacators charge up to the peak of the ac voltage imposed



Underchassis view. C5 & C6 are in foreground, are the tubular type, mounted vertically.

on them, and after rectification more dc results than the average value of the ac input. Output dc is 900 volts with low voltage and bias.

This sextupler voltage multiplier circuit was evolved from the modified quadrupler used in the previous article[1]. Figs. 1, 2 & 3 show how the circuit was developed. In fact, this voltage multiplication process could be extended an infinite number of times, but electroletic capacitors have to be used in series, and when they do the effective capacitance is reduced. So there is a practical limit to this multiplication business, as the regulation begins to suffer as the effective capacity is decreased.

I have never seen this circuit in any of the textbooks, but it is a practical circuit, and the results are excellent. Voltage regulation is good, but not as good as with the quadrupler, due to the fact that the

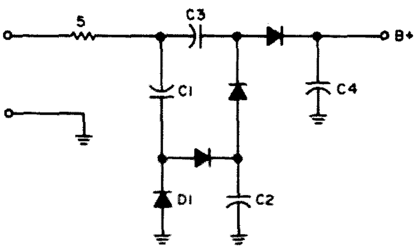


Fig. 1. Conventional half-wave quadrupler. Full output voltage is across C4.

output capacitance is made up with C2, C4 & C7, three 300 mfd. capacitors in series, giving an effective 100 mfd. C5 & C6 in series make up the capacitor for the fifth multiplication. Two 200 mfd. at 450 volt units giving an effective 100 mfd. All capacitors are of the twist-lock, can type, except C5 & C6 which are tubular type, since no manufacturer makes a 200 mfd 450 volt type in a can. The photographs show the type brackets used to mount the tubulars in an upright position on the chassis. The 900 volts high voltage drops about 80 volts under 250 ma voice peaks, which is still under 10% regulation. Not bad for this type of power supply, or any other hv supply. The low voltage tap only drops about 5 volts, under voice peaks.

A 5 x 9 x 2 inch aluminum chassis was used to mount the components on and a front panel was used to mount a 4 in speaker. The photographs show the parts layout, although nothing is critical. The lone transformer is for the filaments, and is surrounded by the forest of capacitors. The schematic of the complete supply is shown in Fig. 4.

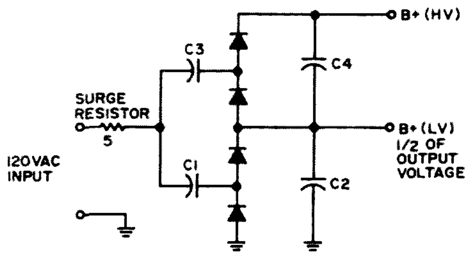


Fig. 2. Modified and redrawn quadrupler. By putting C4 and C2 in series, a lower voltage capacitor can be used for C4.

Mention should be made here of the surge resistor arrangement. It is an absolute necessity to protect the diodes, when the power supply is first turned on and the capacitors look like a dead short; however, after thirty seconds the resistor is shorted out by the time delay relay K1, as the resistor serves no other purpose, and if left in the circuit causes a voltage drop as current is drawn through it. A one volt drop in the input causes approximately a 7½ volt drop in the output voltage at the high voltage tap.

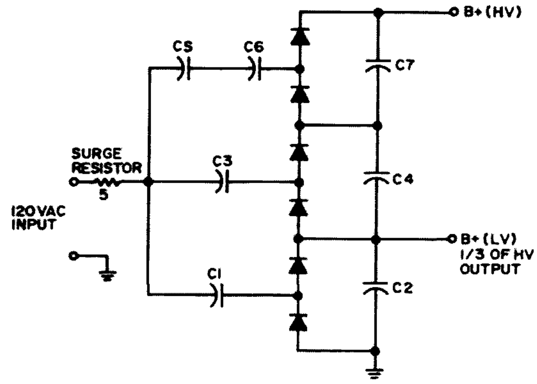


Fig. 3. By extending the circuit of Fig. 2 with two or more diodes and capacitors, we wind up with a voltage sextupler, multiplying the line voltage times six. Two capacitors, C5 and C6, have to be used in series for the fifth multiple because approximately 750 volts appear at this point.

Each diode has an .01 disc ceramic capacitor across it for transient protection.

All of the precautions should be used on this power supply, as were used with the quadrupler, since it operates with one side of the ac line grounded. However, nothing is to be feared if the ac line plug is inserted correctly. This can be determined by two different methods. The first is to run a ground lead from the power supply chassis to a good ground: Cold water pipe, or a driven ground rod. With the switches in the power supply turned off, insert the ac plug into the wall outlet. If the neon bulb ignites, the plug is in correctly. If the neon bulb doesn't light, just turn the plug over, and you are in business.

The other method is to determine which one of the sockets in the ac wall outlet is the neutral or grounded leg of the incoming power. City electrical wiring codes specify that the larger of the two sockets be the grounded or neutral leg, but be sure and play it safe and find out for sure. After you determine which is the hot and neutral, use a polarized ac plug. This is the preferred method, and can be determined with an ac voltmeter, by hooking one lead to a ground and plugging the other lead into either socket which gives you 120 volts. The one that doesn't give a reading is the neutral leg, therefore ground.

This power supply has been used with all of the commercial transceivers on the market requiring an external power supply,

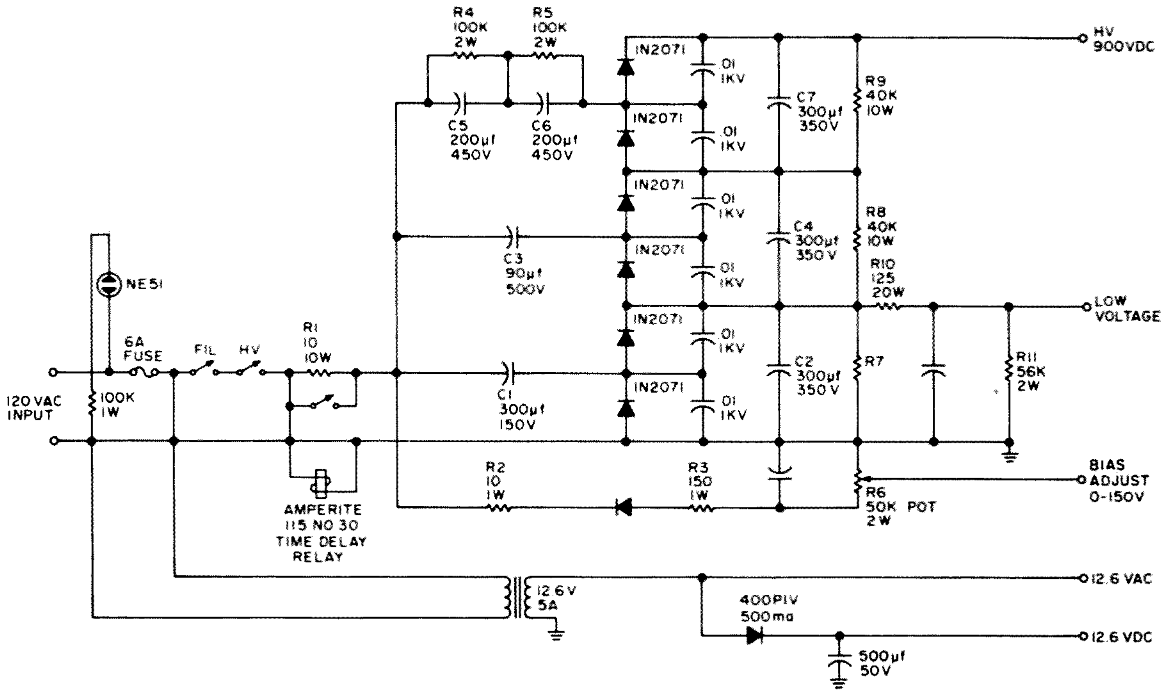
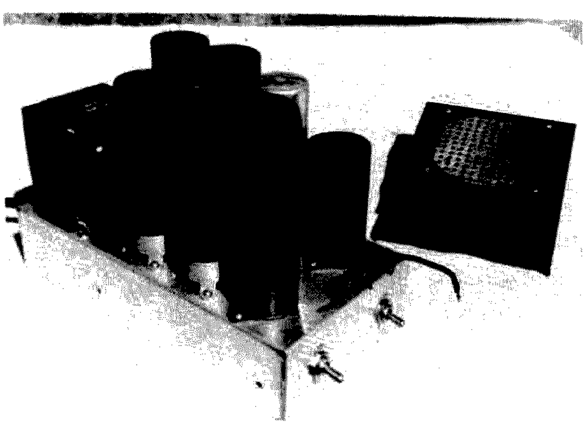


Fig. 4. Complete schematic of sextupler power supply.

with excellent results. The value of R10 may have to be changed to drop the voltage on the low voltage tap to give the correct amount for your particular brand of transceiver. The light weight, 5½ pounds, and good voltage regulation make this type of supply an excellent choice for the modern day, compact SSB transceivers on the ham market today. And the cost isn't too bad. Purchasing all of the parts new, this supply can be duplicated for about $40.00. Quite a savings for the energetic ham who wants to build at least part of his station.



Front panel has been removed to show component arrangement. All capacitors with cans above ground potential have cardboard covers over them for shock protection. C5 & C6 are 2nd & 3rd capacitors from left, front.

One friend of ours who travels quite a good deal by commercial airlines uses this power supply along with a Swan 240 and it makes quite a lightweight and compact station that he carries in a small suitcase aboard the plane without having to pay any excess baggage allowance.

After first building this power supply, it was used to power a linear amplifier using 4 TV horizontal sweep tubes in a grounded grid circuit. The Quadrupler P.S., described in a previous article[1] powered an HW-12 transceiver used as a driver for the linear. With this arrangement we ran 900 watts PEP input, without a power transformer in the whole station. Our next project is to build an Octupler, an eight multiplier, to power the linear.

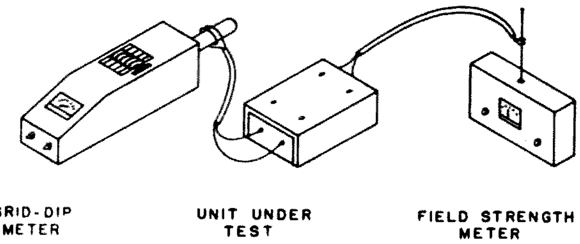
I hope that this article has filled the need for a higher voltage, voltage multiplier type of power supply, for those who wrote and inquired about the possibilities. I answered all letters of request and hope that the information in this article has helped to build a good case for the voltage multiplier and to enlighten the radio amateur on the subject.

. . . W5NGX

1. John R. Bell W5NGX, *A Transformerless Transceiver Power Supply*, 73 Magazine, June 1968, p. 62.

Reliance Check

Have you ever been plagued by the situation of having installed an interference trap or filter, either home built or factory manufactured, only to find out that it does not perform the way you had been led to expect? A sure fire method of pre-testing the interference trap or filter can be found in most ham shacks or can be found at most experimenter's work bench.



All the test equipment needed is a grid dipper, or variable frequency calibrated oscillator with low output; and a field strength meter with a means of indicating signal strength. The trap or interference filter undergoing testing is connected in the following manner: the input leads are connected to a pick-up loop to be connected to the frequency source, such as the grid dip meter or the variable oscillator; the output side of the unit is then connected to a test probe that in turn is connected to the field strength meter; the frequency to be trapped is then set up with the source and the amount of energy passed through the filter can be read out on the field strength meter; the trap or interference filter may then be adjusted to pass the minimum amount of energy at the frequency preset at the signal source. By this method you may predetermine the effective band width of the unit before installation.

This method has been in use at my location for quite a while and has been found to be quite accurate in setting up traps by the tvi committee of our radio club, of which I am a member. It is felt that in passing along this method, some time might be saved in other locations.

W. R. Lingenbrink W6HGX

What's par for the course is sauce for the gander.

Joel Eschmann, K9MLD
2036 Erie Street
Racine, Wisconsin 53402

The Unikey

If you are a CW man like I am and have in your possession, as my wife puts it, a rather oversize junk box occupying one bedroom and 50% of the basement, you will appreciate putting these parts to good use.

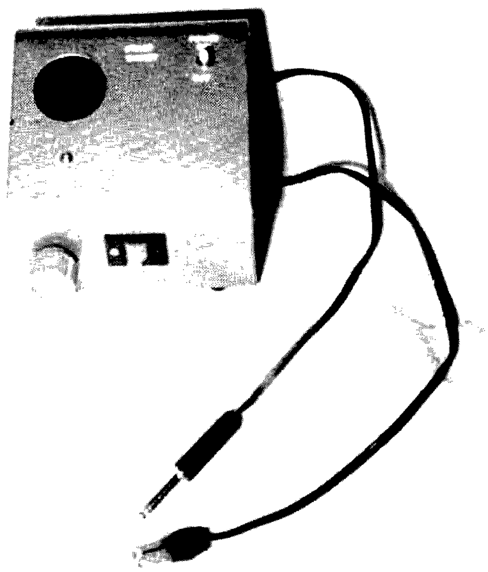
I am an avid 40 meter operator, and while on the air one Saturday morning I couldn't help noticing again the increasing number of automatic keys or keyers. Well, I looked at my wallet and then at my rather large junk box and decided I couldn't buy one right now, but I could build it.

I rummaged for a few minutes and located an old logic module I once used in my many experiments for a clock divider. I pondered with a black board and chalk and arrived at a practical keyer for slow and high speeds – 5 to 30 wpm. I use a sideband transceiver on CW and since I wanted to hear what I was sending, I added a simple sidetone oscillator.

The original unit was constructed in a small sloping-front cabinet with a 110 vac power supply. I approached numerous friends who had a desire for a keyer but wanted it portable for field day activities and, believe it or not, mobile operation. The first unit functioning on a 24 vdc supply, due to the relay used, would of course prove not to be very practical on 12 vdc. Then having to buy a relay, it was felt an important design improvement to use a reed relay which I will explain later.

Circuit Description

This design is very straightforward and easy to understand. It you are like me, you dislike buying or building anything which you don't understand.



The Unikey with side tone.

The keying circuit is made up with (Q1) a 2N2646 unifunction transistor. The unijunction is a remarkable addition to the transistor family. **(Fig. 1.)**

By varying R1 or C1 it is possible to alter the rate of discharge or to change the frequency of the oscillations. In our case speed is achieved by more conveniently varying R1. Utilizing two diodes for what we'll call steering, we are able to electromechanically change speed and switch on the remaining circuitry. **(Fig. 2.)**

Key closed for dash operation, current flow is through only resistor R2 plus remaining stages. R2-R3 plus C1 establishes dash frequency, R1 being blocked with the diode D1. Key closed for dot operation, current flow is through D1-D2, R1-R2, plus R3-C1. Now observe R1 is now across, in

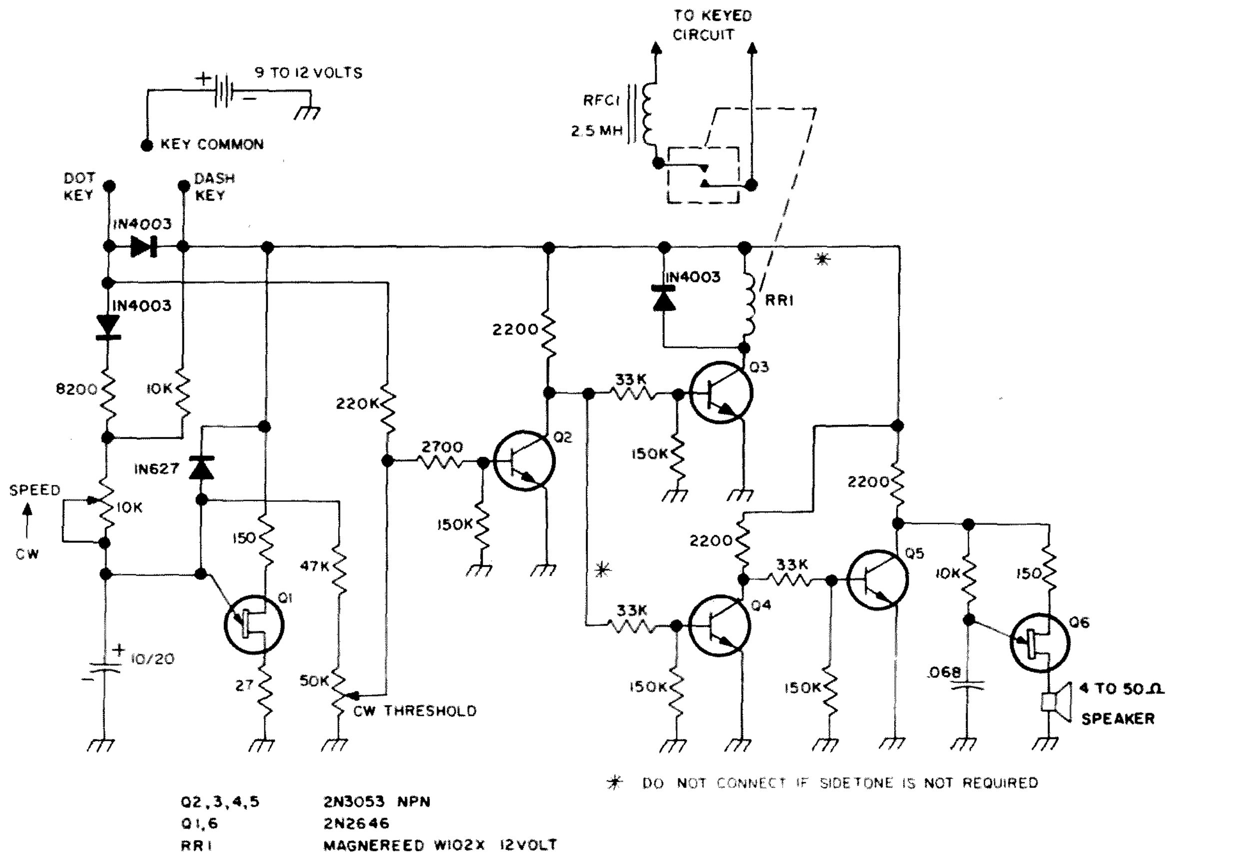


Fig. 1. The unijunction—remarkable addition to the transistor family.

effect, R2 causing a smaller R total which will increase the original dash frequency to establish a dot frequency. The ratio, of course, is fixed in this circuit to minimize adjustment required by the operator.

The desired code speed is adjustable with R3. If the parts described on the schematic are held close to designated values, 5-30 wpm can be achieved. Before proceeding to the remaining stages I would like to explain what might seem like an extra component – a diode from the emitter of Q1 to the supply side of the 150 ohm resistor on Q1's base No. 2. This is an important component which I didn't want to overlook. This diode supplies a discharge path for the capacitor in the emitter circuit of Q1 allowing it to be totally discharged in the event a key open situation would exist in the middle of any character. This way you are guaranteed a uniform character regardless of speed.

Using a sawtooth to switch leaves a little bit to be desired for a proper logic switch, usually a square wave. But, by using some magic, we can cheat a little. We will depend on, for proper logic information, the saturation of Q3 in Fig. 1.

The instant the dash key is closed, RR1 will also close until the proper ramp level is achieved on the base of Q2. This level is adjustable and is set by the operator once. The adjustment is described later. The collector current will rise and the voltage collector Q2 to ground will go to zero approx. causing the base voltage on the base

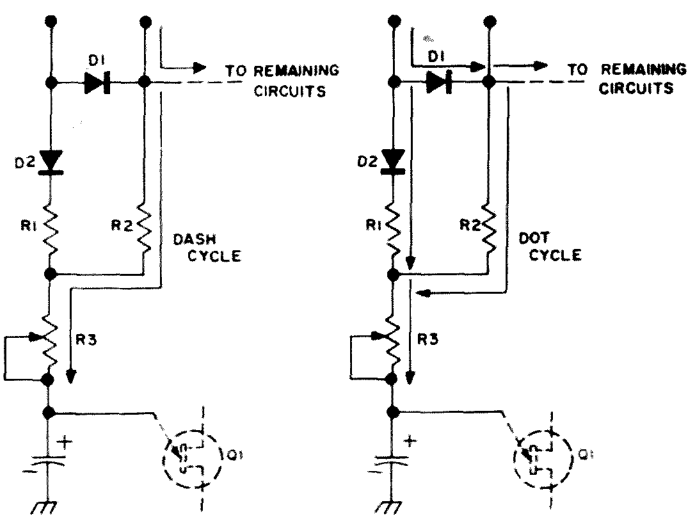


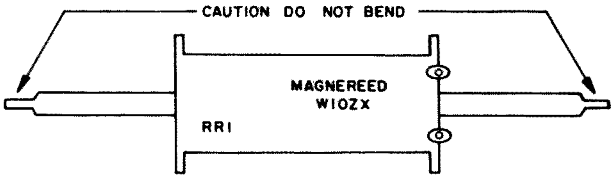
Fig. 2. Circuit during dash cycle.

of Q3 to also go to zero. With the base voltage zero the collector current of Q3 will also be zero causing RR1 to open.

Before proceeding to the dot sequence, I would like to explain the reed relay and my reason for using it. The construction is simple; two iron strips, gold plated, held in close proximity in a glass tube in a vacuum. Surrounding this glass tube is a coil of wire. Simple, isn't it? (Fig. 3.)

When the coil is excited, the contacts act as an armature and close upon becoming magnetized. I used this relay for many reasons: (1) There is no armature mechanics (fewer moving parts). (2) Fixed spring rate (tension). (3) Low current consumption. (4) Large currents can be handled. This means any kind of keying can be used, (e. g. Grid Block, Cathode, etc.). (5) Sealed and quiet. (6) Fast, no contact bounce as compared to a conventional relay. To sum it up: regardless of speed or circuit to be keyed, to practical limits, this unit will out perform a relay. But, not to sound like a salesman, you be the judge.

With the relay theory understood, we can proceed to the dot function. The instant the dot key is closed, RR1 again will close as in the dash description. See Fig. 1. Except for two differences. First, with the steering diodes adding resistor R1 across R2 in Fig. 2 the rate of oscillation of Q1 will increase or speed up. Second, by adding a slight amount of forward bias to Q2 through a 220 k resistor we will in effect change, electromechanically, the point at which Q2 will



REED RELAY

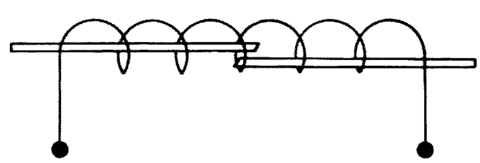


Fig. 3. Construction of reed relay.

conduct giving us the 3 to 1 ratio for a proper dash to dot relationship.

The sidetone circuit, which remains to be explained, can be eliminated if you don't need it. However, its function is desirable, if, like me, you want to hear what you are sending when you use a SSB rig for CW. The sidetone circuit extracts its information, like the relay and keying transistor Q3, from the collector of Q2. Two logic switches, Q4 which shapes the sawtooth to resemble more a square wave and Q5 the sidetone switch, are used. To explain more easily, when Q2 collector is on Q4 is off and Q5 is on. Since Q5's collector has about 10-12 volts on it, this means the unijunction sidetone oscillator has a supply voltage allowing it to run at an audio frequency approximately 1500 hz, which is heard through the speaker in the Base No. 1 lead. The speaker may be 4 to 50 ohms, whatever you have in your junk box.

As for adjustment of the threshold pot, it can be achieved in a number of ways. The best is with a dc scope and applying a supply through the reed switch adjusting for a 3 to 1 ratio on the scope pattern. Next, just listen to the sidetone oscillator and adjust until the proper character is heard. Last, use a VOM to observe a RMS 3 to 1 ratio of collector voltage of Q3. If for any reason the ratio is difficult to achieve, adjust the threshold pot for dash character and change the 220 k bias to set the proper ratio. If the parts described are used, you should have no problems with your keyer adjustment.

Rather than buying different makes and styles of transistors, I thought it well to use only two different ones. The unijunctions 2N2646 and switching transistors 2N3053 NPN both are available at most parts houses. The only unique component is the reed relay. Due to the use of eight small 1.5 volt penlight cells as a source of supply, a low current reed was used. I purchased a 1 amp Magnereed W102X with gold contacts from Allied Radio of Chicago. You will note total current consumption is about 20 25 ma. Excluding resistors, capacitor, speaker and pots, the reed and all semiconductors will cost about $10. Not bad considering what keyers go for these days. See you on forty soon, I hope.

... K9MLD

LETTERS

Dear Editor,

First of all I want to tell you how much I support your idea of a magazine that would be for Novices, SWL's and CB'ers. You see, I'm only 12 and haven't quite got my Novice yet (I hope to soon). But I would mainly like to ask you about this: 1 support Barry Goldwater's Senate Joint Resolution 27 as do many others. As you know, this bill would allow immigrant radio amateurs (permanent residence ones) to apply for a W license.

Steve Antosh
1524 North Oklahoma Avenue
Shawnee, OK 74801

Readers – let your Congressman know you care. Write today.

Dear Wayne,

The article on Broadcast Engineering in the August issue of 73 came somewhat late for me as I had gotten a job with WCWA AM & FM here in Toledo early this summer. This type of work is fun as well as profitable for a ham who is willing to put just a little time to study. As I am only 17 and a Novice, it woufd be no major undertaking for one who is more experienced in electronics. To show how it can be helpful to a younger person, I was employed as a replacement engineer for summer vacations and was able to buy a car just in one summer, and I was kept on as a weekend man when normally just the announcer is on duty. This is going to help keep me in college where before I wasn't sure if I could afford a second year. Keep the good articles going!

Rusty Kinner WN8ZID
736 Holland Sylvania
Toledo OH 43615

Dear Wayne,

Please accept my sincere thanks and appreciation for running the Staff series: *Getting Your Extra Class License*. Although it is not yet complete, I used the published parts to good advantage in taking and passing the Extra Class license when the FCC came to Hartford earlier this month.

It is well written and simplifies difficult theory to the point a non-technical person as myself can properly learn the reason WHY something is so, and not merely memorize by rote, a paraphrased manual.

Ted Melinosky K1GUD
Frederic Road
Vernon CT 06086

Dear Wayne,

The reason you haven't received any manuscripts from me for a while is a long story–an almost unbelievable story–I'll burden you with it.

About three weeks ago, while working on another article for 73, I decided to update my inverted vee. The old clothesline rope kept breaking so I thought I'd go sexy and buy some polypropolene rope. I went to a reputable hardware store and ordered 200 feet of the stuff. The dumb broad that waited on me handed me the spool and told me to stick a finger in each end. Me, a bigger fool, did! She ran down the aisle about twenty feet before I realized that the inserts were metal and that the pencil sharpener action was rapidly putting a good point on my index fingers.

I dropped the spool and bled all over the place. She didn't say she was sorry, but she did toss me a couple of Bandaids.

So for a week I had both index fingers all wrapped up and very, very sore. I couldn't type.

Last Tuesday, with my index fingers about healed, I was installing some plastic water piping and was using my. Swiss Army jack-knife. The blade closed up on me and went right through the nail and over half of the middle finger of my right hand–the tip hung off. 1 puked, called the ambulance and went to the hospital. They sewed the silly thing back on and put a bandage on it.

It is that finger that, when raised singularly from a closed fist (shades of Jackie Mason), can get you a fat lip, for it has far reaching implications. It throbs like mad and I have come close to getting that fat lip on anv number of occasions since Tuesday. Because it does throb, I have to hold the arm up and keep the other fingers away from it. So, as I walk around, it appears as if I were giving everyone the finger.

When the big bandage comes off the digit I'll be back at the typewriter and get more articles to you.

Bob Manning
Box 66
West Rye, NH 03891

Dear Wayne,

Many thanks for the August article "The Genesis of Radio Reception." It was interesting and Bill Hood appears to have done considerable research on the subject. But Mr. Hood didn't research one area well enough. Marconi was NOT "the first to use radio waves over a great distance . . . able to transmit for several miles." Through the arduous efforts of Thomas Appleby W3AX it has been fully documented that the honor belongs to Doctor Mahlon Loomis, a Washington, D. C. dentist. The 89th Congress passed a Joint Resolution to this effect in 1965.

In 1864, Dr. Loomis invented the first wireless telegraph communications system and in 1866 he demonstrated two way wireless communication over a distance of eighteen miles between two Virginia mountain peaks. In 1869, Loomis petitioned the U. S. Congress for a $50,000 grant to develop his system (it was refused). In 1872 (two years before Marconi was even born), Loomis was granted the first patent (#129,971) ever issued by the U. S. Patent Office for a wireless system. Finally, in 1873, the U. S. Congress granted him a charter incorporating the Loomis Telegraph Company.

Dr. Loomis was a far sighted man as well as a unique scientist. He envisioned world-wide communications using his wireless system and even developed a means of electrically fertilizing his garden by sending a current through underground wires. In 1860, before his wireless years, he replaced the battery system of a 400 mile telegraph line with a kite system that tapped the electrical charges of the upper atmosphere. And Loomis didn't neglect his profession. He is acknowledged by the dental profession to be the inventor of artificial teeth and held U. S., British and French patents for the false choppers. Other patents included the electrical thermostat and a cuff or collar fastener.

FLASH!

The FCC announced September 24th that they had decided to abort the further changes in the CW bands set for November 22nd. Ditto the further changes in six meters. The changes in the phone allocations will go through as proposed.

Until recently most of Dr. Loomis' accomplishments were unrecognized. However, Tom Appleby's interesting book "Mahlon Loomis, Inventor of Radio" has given credit to this remarkable man. The book can be obtained directly from W3AX ($3.25) at 5415 Connecticut Ave., N. W., Washington 15, DC.

Wm. B. Shepherd W3ZSR
12,000 Twin Cedar Lane
Bowie MD 20715

Dear Wayne,

Here are my comments on the Diamond letter in September (p.154). First, I wonder if Mr. Diamond is a ham and if so why he doesn't give his call? I also wonder if he is an "Engineer" (registered professional engineer) in the State of California? Any examination is hard, even the first phone, if you don't know the answers. My son (16) passed his General today and did not do it by memorization. He learned the theory! The broadcast industry also has its six-week wonders with first phone tickets gained by memorization. I had my commercial license before I got my ham ticket, but perhaps it was "easy" when I took the exam 18 years ago. I have been on the air for 16 years on AM-FM-SSB-CW-RTTY and have built more equipment than I care to remember. I now use commercial gear and so does WØBL (KATZ), WØBK (KXOK) and WØLWG (KWK), all chief engineers. We have all been around a few years in the broadcast and ham game and when we hire a technical person, a ham license is his best recommendation!

Meivon Hart WØIBZ
WIJ
St. Louis MO 63101

(continued on page 132)

NO-NO Frequencies

Here is a list of frequencies you are no longer able to use, courtesy of Incentive Licensing. This may be a bit easier to follow than the long lists of permitted frequencies.

License	22 Nov., 1968	22 Nov., 1969
Advanced	3,500 - 3,525	3,500 - 3,525
	3,800 - 3,825	3,800 - 3,825
	7,000 - 7,025	7,000 - 7,025
	14,000 - 14,025	14,000 - 14,025
	21,000 - 21,025	21,000 - 21,025
	21,250 - 21,275	21,250 - 21,275
General & Conditional	3,500 - 3,525	3,500 - 3,525
	3,800 - 3,850	3,800 - 3,900
	7,000 - 7,025	7,000 - 7,025
	7,200 - 7,225	7,200 - 7,250
	14,000 - 14,025	14,000 - 14,025
	14,200 - 14,235	14,200 - 14,275
	21,000 - 21,025	21,000 - 21,025
	21,250 - 21,300	21,250 - 21,350
	50,000 - 50,100	50,000 - 50,100
Technician	50,000 - 50,100	50,000 - 50,100

E. H. Conklin, K6KA
Box 1
La Canada, Calif. 91011

Transistor Power Supplies

Although the ideal situation may well be to leave factory-made equipment as is, without modification, it is sometimes necessary to add some function or accessory. When this is done, it is most desirable to leave the equipment unaltered if possible or, at least, so little modified that it can be restored to "mint" condition in a few minutes. Even with such a limitation, there are many things that can be done.

Some equipments provide jacks or sockets from which filament and plate power can be taken for such devices as vhf converters. The additional load, however, will add to the transformer heat and may exceed desirable limits. On the other hand, accessories which use transistors may draw so little current that the savings of the power in one tube heater in the equipment may actually provide more than enough power for all accessories that might be added.

Batteries and added power supplies have some bulk and may involve inconveniences of interconnection. On the other hand, the filament transformer in the original equipment can be used conveniently in almost every case. Let us examine some of the situations and solutions to the transistor power-supply requirement.

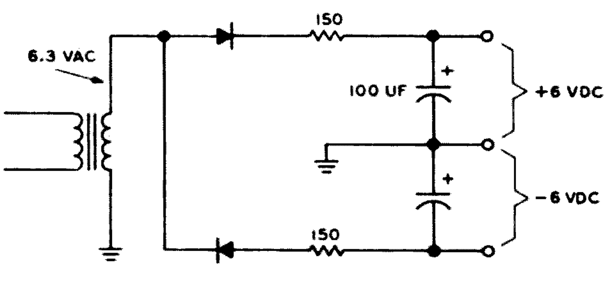


Fig. 1. Circuit for obtaining both plus and minus six volts to ground.

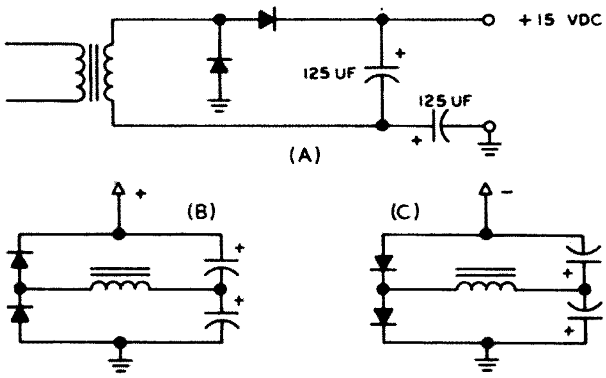


Fig. 2. Voltage doubler circuit. 2B has negative grounded. 2C has positive grounded.

It may be assumed that most existing amateur radio equipment using receiving tubes has a 6.3-volt filament transformer, one side of which is grounded to the chassis. For transistor use, sometimes this voltage is a bit low, and it may have to provide both positive and negative polarity to ground in a dc supply. In a few cases, the accessory may be designed to include transistor circuits which are carefully left ungrounded for dc, with bypass capacitors isolating the circuit from any connections that might reach ground. Coaxial cables, for example, may have to be provided with two blocking condensers—one for the inner conductor, and one for the shield braid.

A very simple circuit for obtaining both plus six volts and minus six volts to ground appeared in the "Der Kleiner Keyer" articles in 73 for September, 1965, and May, 1966. This is shown in Fig. 1. Actually, the voltage varies considerably depending upon the for-

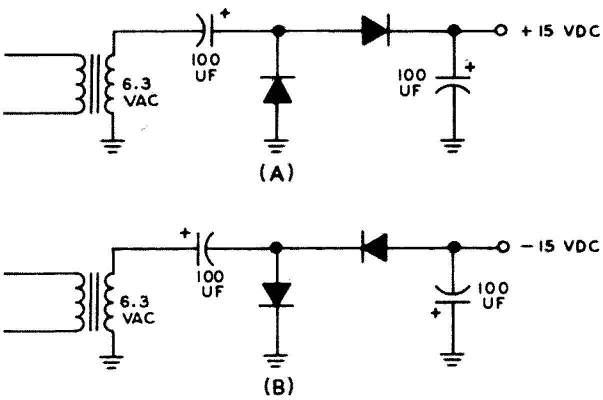


Fig. 3. The filament transformer can be grounded. 3A is negative grounded and 3B has the positive grounded.

ward resistance of the diode, the size of the series resistor (which with other circuit resistance must limit the charging current of the capacitor—practically a short circuit—to a safe surge value for the diode), and the amount of bleeder and useful load.

In addition, there are several voltage-multiplying circuits described by Jim Kyle and Murray Baird in 73 for February, 1966, and December, 1965. A widely-used doubler supply is that shown in Fig. 2A. Two diodes in each leg—a total of four—are used in the SB-400 for the 800-volt supply. Eight in each leg on an 800-volt transformer without protective resistors or capacitors across the diodes, but with resistors on the series electrolytic capacitors, furnish roughly 2,000 volts at a kilowatt in the SB-200.

The above circuit may be redrawn as shown in Fig. 2B with grounded negative; but it can be arranged as in Fig. 2C for grounded positive. The same transformer can be used in two such supplies, provided that all circuits fed by one power supply are isolated for dc from the circuits fed by the other. Also, because both ends of the transformer are above ground at dc, the circuits fed by

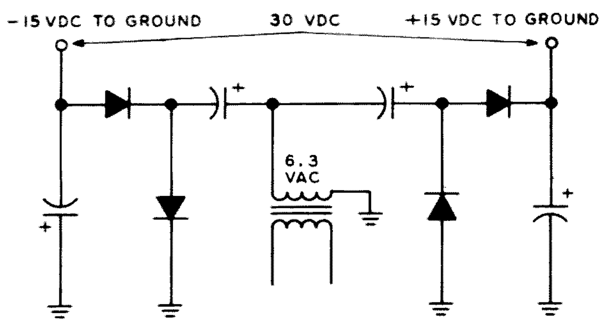


Fig. 4. By combining circuits in 3A and 3B, we can get up to 30 volts out at no load.

such power supplies when using a grounded filament transformer, must be isolated from chassis ground. The usual 6.3 v transformer in radio equipment will produce 15 volts under no-load conditions in this doubler circuit.

By moving one capacitor to the other end of the transformer, a slightly different circuit is obtained which allows one side of the 6.3-volt filament transformer to be grounded to the chassis without isolating the circuits fed by a rectifier and filter connected to the transformer. This is shown normally for positive output as in Fig. 3A. It can be reversed to provide negative power as shown in Fig. 3B. In each case, it produces 15 volts under no load.

At the expense of isolating circuit grounds, the circuits of Fig. 3A and Fig. 3B can be combined on the same 6.3 v filament transformer, as shown in Fig. 4, to produce a no-load voltage of 30. This may seem a little like lifting oneself by his bootstraps, but it is a great convenience for producing voltages for transistor gadgetry in existing tube-type radio equipment. . . .K6KA

Bias Design Without Curves

Clifford Klinert, WB6BIH
520 Division Street
National City, CA 92050

Many amateurs have the impression that transistor bias design requires complicated calculations, and detailed graphical analysis. Complete gain and frequency response calculations usually do require quite complicated analysis, but the basic caluculations for getting a circuit to work are within the capabilities of almost all experimenters. This article is presented to show that a few simple calculations before assembling a circuit can eliminate a good deal of guesswork and experimentation that can be better spent on other problems.

Class A Bias Circuit

Fig. 1 shows the familiar class A bias circuit. In the discussion for this circuit we will deal only with dc bias values. As a review, Fig. 1 shows some of the important voltages in the circuit. Vcc is the supply voltage, Vb is the base voltage supplied by the voltage divider R1-R2, and Vre is the voltage drop across the emitter resistor. Vbe is the forward biased base-emitter junction voltage drop. In silicon transistors Vbe is about 0.6 volts, and in germanium transistors this is about 0.2 volt. To simply explain how this circuit operates, we will visualize the effect of changing the R1-R2 ratio. Changing this ratio will either increase or decrease Vb, and thus change the bias on the transistor. As Vb is increased the transistor is increasingly forward biased, and the collector-emitter current increases. Think of the transistor as a switch. The base bias controls the collector current so that the collector and emitter are the two terminals of a switch with the base as the handle. With the transistor turned off the collector emitter voltage, Vce, is equal to Vcc, and no current flows. With Vb high, the transistor is turned on and Vce is zero. This is the maximum current point where the collector current, Ic, is given by Ohm's law as :

$$I_c = \frac{E\ \text{total}}{R\ \text{total}} = \frac{V_{cc}}{R_c + R_e} \qquad (1)$$

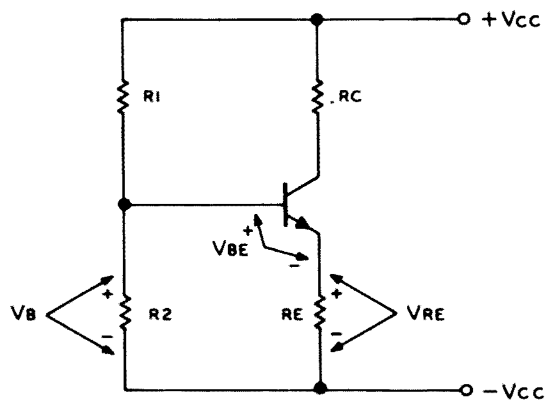


Fig. 1. Transistor bias circuit. This is only for dc values and coupling and bypass capacitors have been omitted.

It is frequently helpful to draw a rough sketch of the circuit action with use of these two current and voltage points. Fig. 2 shows how we can illustrate the "switch" action of the circuit. The two points are plotted, first where the current is maximum and the voltage is zero, and then where the current is zero and the voltage maximum. Between these points a straight line is drawn to show what the current and voltage in the collector-emitter connection does. The collector voltage (and current) must travel up and down this line to give the varying (ac) output signal. For maximum effectiveness in class A we must adjust the bias to put the collector current (and voltage) somewhere between these two points on the line. This bias point is where the transistor circuit rests

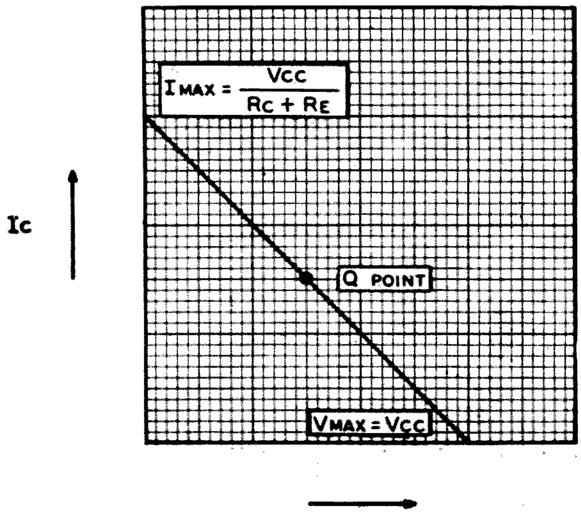


Fig. 2. Collector voltage and current. The Q point is where the current and voltage rest with no signal.

with no signal, and is called the quiescent point or Q point. The location of the Q point will vary with the type of transistor and circuit requirements, but it is usually placed toward the middle of the line. This is shown in **Fig. 2**. The major portion of this article will be devoted to finding bias values to set the bias at a specific Q point.

Simplified Base Circuit

The circuit of **Fig. 1** can be simplified to the circuit of **Fig. 3** by combining R1 and R2 and showing Vb as a separate battery. By making some approximations **Fig. 3** can be further modified to **Fig. 4**. This is possible if we assume that the dc current gain, hFE, is much greater than one, and that the collector rent. Rb is the equivalent resistance of R1 and R2 in parallel:

$$Rb = \frac{R1\ R2}{R1 + R2} \qquad (2)$$

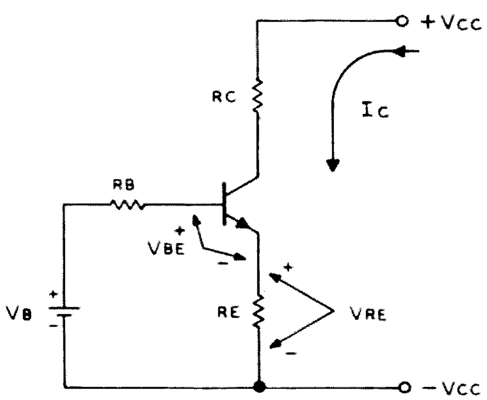


Fig. 3. Equivalent bias circuit. R1 and R2 are combined into Rb, and Vb is represented by a battery.

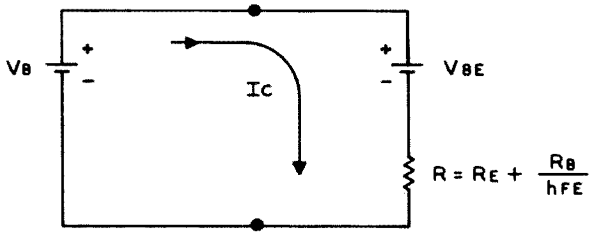


Fig. 4. Base-emitter simplified circuit. Some values are changed to the collector-emitter side to find Ic.

Vb is obtained from the voltage divider formula:

$$Vb = \frac{VccR2}{R1 + R2} \qquad (3)$$

To transfer to the collector-emitter side of the circuit, Rb must be divided by hFE to account for the amplification effect from base to collector. Now in **Fig. 4**, we have the relation between the base voltage and the collector current in one simple circuit. The equivalent resistance in **Fig. 4** is the sum of Re and Rb transfered to the collector circuit. The equivalent resistance, R, is

$$R = Re + \frac{Rb}{h_{FE}} \qquad (4)$$

Vbe is shown as a battery.

To mathematically show this relation between Vb and Ic, we use Kirchoff's and Ohm's law around the loop of **Fig. 4**. Taking the sum of the voltage drops:

$$Vbe + IcR - Vb = 0 \quad \text{or}$$
$$Vbe + IcR = Vb \qquad (5)$$

Take a look at what we have now. If we know Vcc, R1, and R2, we can use equation 3 to find Vb. Equation 2 will get Rb. Vbe is either 0.6 or 0.2, depending upon whether the transistor is silicon or germanium. R can be found from equation 4 with hFE and Re specified. We can now use equation 5 to find Ic. With a little algebra,

$$Ic = \frac{Vb - Vbe}{R} \qquad (6)$$

The previous discussion has shown the relations between voltages, resistances, and currents in the bias circuit. In the next section we must make a few decisions and reverse the process to find the circuit parameters.

Determining Circuit Parameters

The most important thing to first consider is the stability factor, S. A simple formula for S is

$$S = 1 + \frac{Rb}{Re} \qquad (7)$$

Like some of the previous equations, this is a simplified approximation that will make calculations easier. Actually S might be better called the *instability factor* because the larger S is, the less stable the circuit is. Stability will be discussed in greater detail later, but if a circuit is said to be stable it simply means that it keeps its Q point at the same spot. A look at a few commercial designs shows that a factor of ten is a common value for S. For high reliability designs, S may be as low as three or four. For amateur circuits where temperature variations are not severe, values of twenty or more may be used.

Looking at equation 7, we see that the main determining factor for S is the ratio of Rb to Re. Since this is only a ratio, we must turn to other information for absolute values. This further information is supplied by the voltage drop across the emitter resistor. Many commercial and military designs use a voltage drop of two to four volts for Vre. Vre is obtained from Ohm's law by

$$Vre = Re\ Ic \qquad (8)$$

Now we have all the information necessary to design a working bias circuit. We first decide on the Q point which determines Ic. Next a value for Vre is selected. Using equation 8, Re is found. Using equation 1 with the maximum Ic, Rc is determined. By picking an S factor Rb is obtained from equation 7. With equations 4 and 5, Vb is determined. Since we know Vb, Vcc, and Rb, we can use equations 2 and 3 to find R1 and R2. This gives two equations with two unknowns, making an algebraic solution possible. The solution to this problem results in the following:

$$R1 = Rb\frac{Vcc}{Vb} \quad \text{and} \quad R2 = \frac{R1\ Vb}{Vcc - Vb} \qquad (9)$$

Thus the complete path that we must take has been outlined. In the next section we will pull a transistor out of the junk box and see how this procedure works.

Designing a Bias Circuit

In a project with a vfo, I found an old 2N910 to use for a class A buffer between the vfo and a following class C stage. A check of the manufacturer's specs revealed the following numbers:

h_{FE} = 80 min. to 200 max. (at 5 ma)
BV_{CBO} = 100 volts
Pt = 1.8 watts (with heat sink at 25°C)

After brief consideration, the decisions about the Q point were made. Since the hFE ratings were given at 5 ma, this was selected as the Q point. Vcc was chosen as 22.5 volts because this was the voltage available, and is within the manufacturer's ratings. With the Q point at the center of the line as in Fig. 2, the maximum Ic is twice the Q point Ic, or 10 ma. To determine the actual value of hFE of the transistor, it was inserted into a bias circuit with variable resistors and the hFE was measured. Most experimenters probably have some method of testing transistors to determine this parameter. In this case the hFE was found to be 133. This is only good for the conditions of the test, and is only an approximate value. Since this circuit might be used along with tube amplifiers, a low S factor of 3 was chosen for Vre. More details on the selection of these parameters will be discussed later, but now we just want some values to work with to test our equations.

The total resistance in the collector–emitter circuit is determined from the maximum Ic and Vcc:

$$Rtotal = \frac{Vcc}{Ic\ maximum}, \qquad (10)$$

where R total is the sum of Rc plus Re as in equation 1. From this we obtain:

$$Rtotal = \frac{22.5\ volts}{10\ ma} = 2.25\ K\ ohms.$$

For a voltage drop of two volts across Re, with Ic equal to 5 ma (at the Q point) we use Ohm's law:

$$Re = \frac{Vre}{Ic} = \frac{2\ volts}{5\ ma} = 400\ ohms.$$

Now that Re is known, Rc can be found by subtraction:

$$Rc = Rtotal\text{-}Re = 2.25K\text{-}.4K = 1.85K\ ohms.$$

With Re known, Rb can be found from equation 7 with S factor as three. Equation 7 becomes

$$Rb = Re(S\text{-}1) = .4K(3\text{-}1) = .8K = 800\ ohms$$

To find Vb R must be found. From equation 4 we have

$$R = Re + \frac{Rb}{h_{FE}} = .4K + \frac{.8K}{133} = .406\ K$$

Using equation 5, Vb is determined.

$$Vb = Vbe + IcR$$

$$= 0.6 + 5 \text{ ma} \times .406 \text{ K} = 2.63 \text{ volts}$$

The 0.6 volts came from the fact that the transistor is silicon, and Vbe is 0.6. Now that we have Vb, R1 can be found in equation 9.

$$R1 = Rb \frac{Vcc}{Vb} = .8 \text{ K} \frac{22.5 \text{ volts}}{2.63 \text{ volts}} = 6.85 \text{ K}$$

Also R2 can now be calculated.

$$R2 = \frac{R1\ Vb}{Vcc - Vb} = \frac{(6.85K)(2.63 \text{ volts})}{22.5 - 2.63 \text{ volts}} = .91K$$

Well, there you are. The values can now be applied to Fig. 1 and we have an amplifier. However, you may have some trouble finding all the precise resistor values at your neighborhood electronics store. I picked the closest values I could find, and went through the calculations again. I obtained a calculated Q point of 4.95 ma which is quite close to the desired value. By breadboarding the circuit, the current was quickly measured. The current was 4.8 ma. This result is quite good considering the approximations used. Even if exact formulas were used, the values of the resistors could not be specified exactly, and even if we measure the hFE of the transistor, it will change considerably at other temperatures. Thus, there is little point in using calculations that are any more precise than is necessary.

Bias Stability

As was stated previously, one of the most important considerations before designing a bias circuit is circuit stability. By using regulated voltages and fixed resistances in the circuit only one thing is left to cause bias changes—the transistor. There are three factors that can change in the transistor, either with different environments or with different transistors of the same type. Professor W. L. Brown of the San Diego State College School of Engineering has presented simplified equations to show the effects of these three factors.

The first factor is I_{CBO}, the leakage current. The change in Ic can be approximated by

$$\frac{\Delta Ic}{Ic} = \frac{\Delta I_{CBO}}{Ic} (1 + \frac{Rb}{Re}) \quad (11)$$

The change in collector current from equation 11 is in percent of the Q point current. The change in I_{CBO} will usually have to be determined from manufacturer's specs or by experiment. However by the use of one simple measure, this effect can be completely eliminated from our calculations. If we use silicon transistors instead of germanium, this consideration can usually be neglected. As a matter of fact, silicon transistors are much more widely used than germanium.

The second effect to be considered is the change in h_{FE}. The h_{FE} of transistors of the same type may vary over a two-to-one spread or more. There is a manufacturer who makes transistors that are each marked with its own h_{FE} by attaching an IBM card to each transistor. When a large order comes in the transistors are simply sorted for the desired specifications and the number of the ordered transistor is marked on each transistor. There is very little point in making the h_{FE} very precise because it may change by a factor of two to one with temperature. However, with the knowledge of how the change in h_{FE} affects the change in Q point current, we can design the circuit to minimize this effect. The simplified formula for this is:

$$\frac{\Delta Ic}{Ic} = \frac{\Delta h_{FE}}{h_{FE1}\ h_{FE2}} (1 + \frac{Rb}{Re}), \quad (12)$$

where h_{FE1} and h_{FE2} are the minimum and maximum values of h_{FE}. We again see that the old familiar Rb over Re factor (or the S factor minus one) must be small for the change in Ic to be small. However, there is another factor that is interesting. Suppose h_{FE} changes from twenty to thirty, giving a change of ten. With S equal to five:

$$\frac{\Delta Ic}{Ic} = \frac{10 \times (5)}{20 \times 30} = .0835 = 8.35\%$$

This is a small change, but suppose we use a transistor with a h_{FE} of two hundred to two hundred and twenty. This is still a change of ten in h_{FE} but

$$\frac{\Delta Ic}{Ic} = \frac{10 \times (5)}{200 \times 220} = .00113 = 0.113\%$$

which is a much smaller change. So by using a low S factor and high h_{FE}, high stability can be secured.

The last important factor in bias stability is the effects of change in Vbe. The change in Vbe is rather predictable and is usually

about -2.5 millivolts per degree centigrade.

$$\frac{\Delta Ic}{Ic} = \frac{\Delta Vbe}{Vre} \qquad (13)$$

is the simple equation for the effects of change in Vbe. This brings us to the fact previously pointed out about Vre. High values of Vre will minimize the effects of Vbe because Vbe and Vre are both in the base circuit. The large value of Vre will tend to overshadow the small changes in Vbe. As previously stated, the voltage for Vre is usually about two to four volts in commercial and military designs. Note that it is the voltage that is important, and just having a large Re will not help if the collector current is small.

Don't go too far in trying to make a circuit more stable. If a value of Rb over Re is one or less a point of diminishing returns results. The gain of the circuit will suffer because of the low resistances that tend to load down the signal. Also, a small value of Rb in the R1-R2 voltage divider will pull considerable current from the power supply. This current drain is essentially wasted because it does not contribute to amplification. If the unit is to be used portable or mobile, this will become an important consideration because of shortened battery life and low efficiency.

Conclusions

The first part of the discussion may have seemed a bit detailed, but the actual design of a bias circuit actually only takes a few minutes with pencil and paper. A little practice and experimentation will result in a good deal of satisfaction. It really gives quite a feeling of "power" to be able to make some marks on a piece of paper, and then built a circuit that works exactly as you predicted. Even though most of these calculations are not exact, the results will be very close. In small signal class A audio amplifiers, a shift or error of as high as thirty percent is usually acceptable anyway. Even though calculations are not made, the simplified formulas present an indication of how the circuit works, which is also helpful. So, the next time you design an amplifier, check a few of these equations first to be sure that your endeavor will be a success.

. . . WB6BIH

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FM Receiver Tweeker

I've found that the singlemost piece of needed test equipment by the amateur on FM is a receiver alignment generator. Most of us, however, do not have access to a signal generator. (Come on now, you wouldn't really call that *TV thing* a signal generator would you?)

The unit to be described is a very functional device that will allow you to scrape every ounce of sensitivity from your receiver. The generator can be built so small you can carry it around in your shirt pocket. Compactness, combined with its battery-powered portability make it ideal for servicing mobile receivers. Stability? It's crystal controlled and is as good as the rock you plug in (you obtain the rock from your transmitter). Output reactance? Nearly zero degrees, allows proper tuning of rf stage. The attenuator shown does not have a great deal of dynamic range due to distributed capacity of the potentiometer. However, I said before, the unit was "functional" and it is just that. The signal can be attenuated into the noise and brought up to approximately a 30 uv level; overly sufficient for a normal alignment.

Construction

The circuit layout is not particularly critical, and if laid out in a manner similar to the schematic, no problems should be encountered. The attenuator section should be completely shielded away from the oscillator and multiplier stages, so rf leakage will not be a problem. A crystal socket should be provided so the unit is versatile for any frequency. However, if you plan on using it on only one channel and can spare a crystal, build it with the crystal inside. Two glass piston screwdriver adjusted trimmers must be provided (to "rubber the crystal" and tune the output to resonance) as front panel controls.

Circuit

Transistor Q1 in the first stage is a crystal oscillator which is very loosely coupled to Q2 the multiplier. This stage is biased into "class C" so as to multiply the 6 mhz crystal 24 times, up to the two-meter band. (3 mhz crystals will also work at a multiplication of 48.) Another important function of this stage is to attenuate the oscillator output (about 6-7 volts peak-to-peak) to a level usable at the two-meter frequency for align-

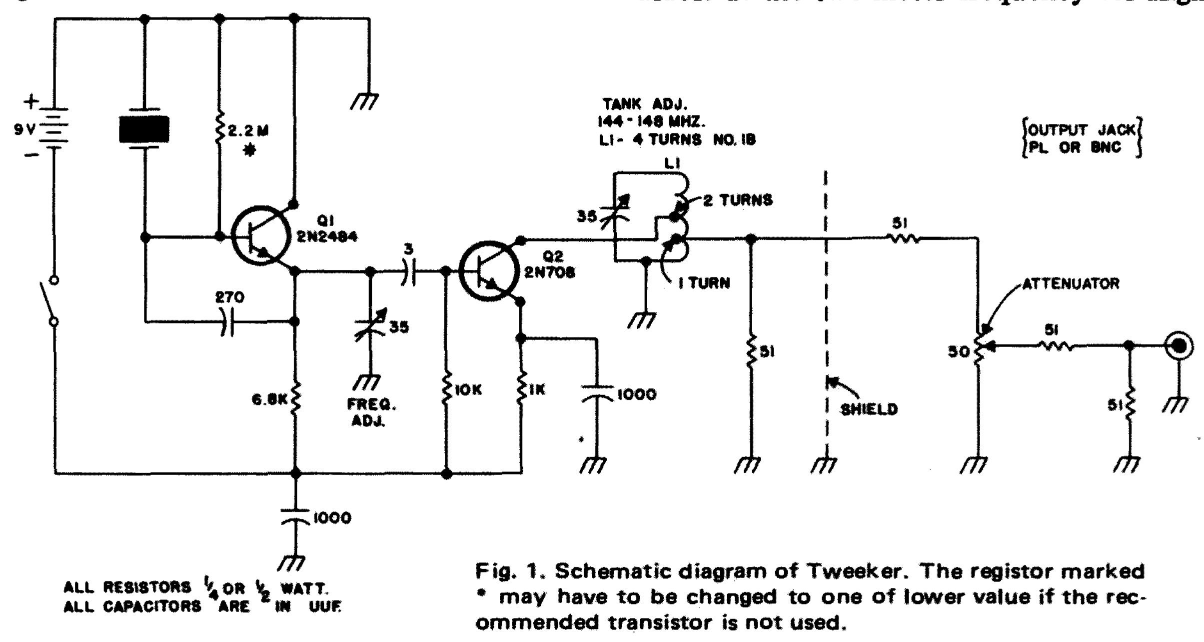

Fig. 1. Schematic diagram of Tweeker. The registor marked * may have to be changed to one of lower value if the recommended transistor is not used.

Shielded rf Chokes or Coils?

The tighter we pack radio frequency circuits, the tougher become the problems of shielding. To be efficient, a shield has to either reject or absorb the *rf* energy. Of course we can use toroids, and, not to belittle them, they are now being used in commercial hf equipment to good advantage. Toroids have one disadvantage, either they have one turn or a multiple of that, or they don't. And, winding them for high inductance takes time or a machine.

Pot cores are nearly as good for the self-contained shielding effect. They are very much cheaper. Plastic bobbins are quite inexpensive and very easy to wind by hand or with an electric drill at slow speed. For moderate values of inductance, no winding is necessaary. Simply take a pi-wound *rf* choke, remove one of the pies (sections), and slip it into the pot core. No mechanical tightening or potting is necessary. Q is much higher than the equivalant air wound coil or slug tuned coil. If the inductance is too high, and it usually is, simply unwind turns.

Roy A. McCarthy, K6EAW

ment – 30 to 40 uv. The potentiometer adjusted attenuator takes the signal down to a level as desired by the operator.

I developed this unit for use on two meters. Several have been built and all work fine. But, for those of you who need a six-meter generator, this same circuit should work fine with the only modification needed being the final tank frequency. (A few more turns on the coil and a slightly larger trimmer capacitor.)

Adjustment and operation

Connect the output of the generator to your rig. Plug in a crystal and tune for zero (with frequency adjustment) on the discriminator (center frequency). Now, looking at the first limiter voltage, peak the final tank. Attenuate the generator as necessary to avoid saturation of the limiter. Repeat as necessary until a definite peak is reached.

If the generator will not go down into the noise with the attenuator control, the final tank may be detuned as necessary to provide the desired range on the attenuator.

... K6UAW

A Mate for the Swan 350

Anthony Sperduti WB2MPZ
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Hamburg NY 14075

I have been operating the Swan 350 Transceiver for a year and a half and outside of a few bugs and minor breakdowns, think that it is a very versatile and dependable rig. But I missed having Vox, a crystal calibrator and selective sidebands.

Swan did make the TCU (Transmitter Central Unit) for the Swan 240 Tri Band (80-40-20-) Transceiver. The TCU includes these goodies plus a built-in speaker, but unfortunately does not have a side-band selector. The TCU is available inexpensively, so I bought one and adapted it for use with the 350.

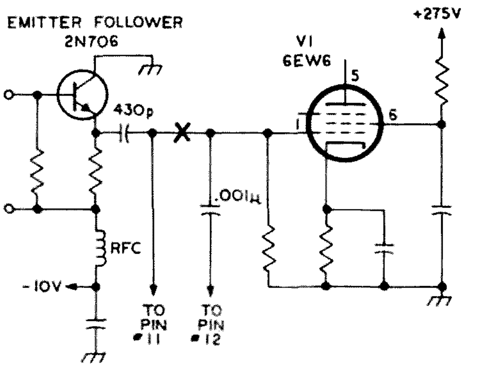
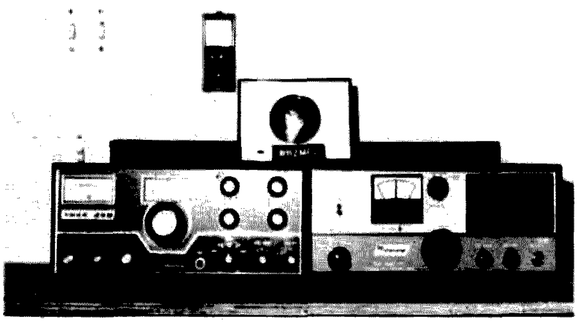


Fig. 1. Partial circuit of Swan 350 VFO. Cut wire at X and run one lead down to pin No. 11 and another lead through a .001mf cap. to pin No. 12 of the twelve pin accessory socket.

Remove the tube socket, .01 capacitor, 1000 ohm resistor cut off a small brown wire from the harness which is attached to the 12 pin receptacle supplied with the TCU. Discard these items as they will not be needed.

Install the receptacle in the accessory hole in back of your Swan 350 and connect according to **Fig. 1 & 2.**

The only necessary changes on the TCU are the rewiring of the VFO selector and the addition of a 12V. SPDT RC Relay. **Fig. 3.**



Swan 350 along side the Swan TCU. They are the same height, length, depth, and make a nice-looking pair.

There are a number of different ways to control this relay. The relay must be in the de-energized position to receive on VFO A,

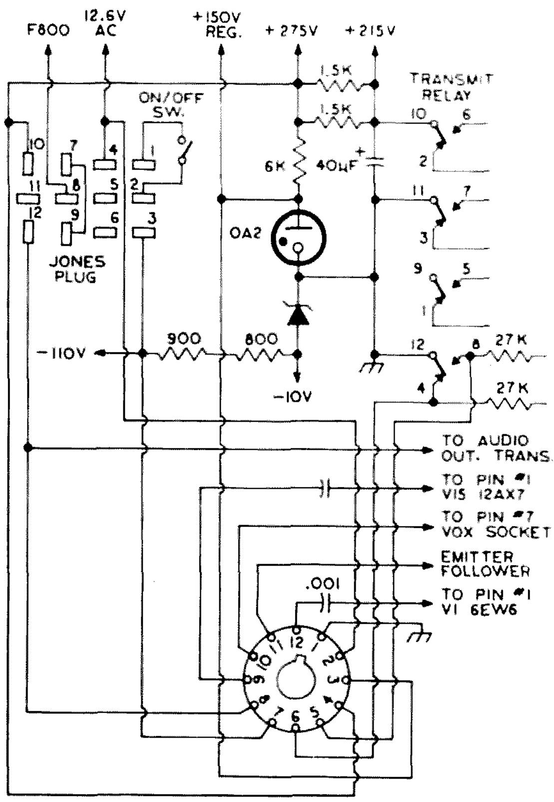
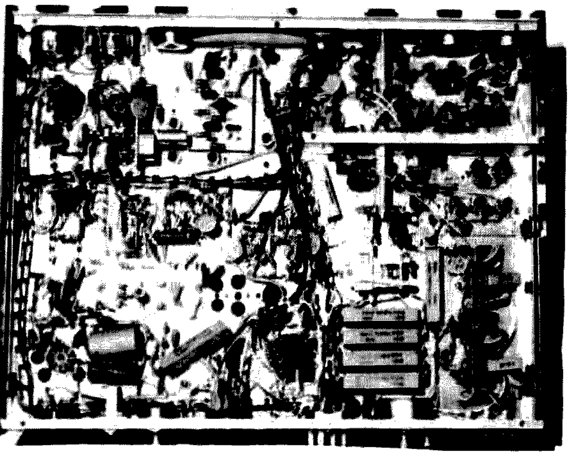


Fig. 2. Partial circuit of Swan 350. Connections of the twelve pin accessory socket to the Swan 350 circuit.



12 pin receptacle is installed at bottom center of photo. Note harness running to printed circuit VFO and where 2 lug terminal strip is placed.

which is the VFO in the Swan 350 and in the energized position to transmit VFO A. The only fault I have found with the way I have done it is that the vox relay must operate in order to energize the RC relay. This can be overcome by running another lead from the TCU to the 350 microphone jack for relay control. Also by running one wire, you could eliminate the need of taking 12 volts ac from the filaments of the TCU and rectifying it to operate the relay.

When you operate the Swan 350 mobile or without the TCV, a jumper must be installed from pins 11 to 12 instead of from 11 to 1. The Crystal Calibrator on the TCU did not give me much volume in the trans-

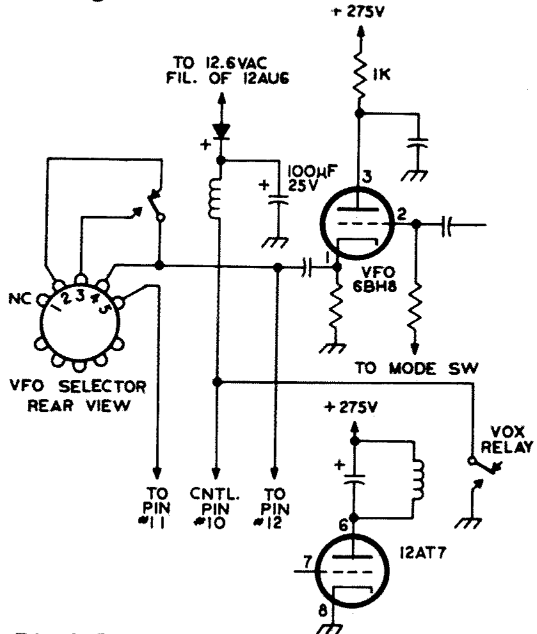


Fig. 3. Partial schematic of the TCU. Changes on the TCU VFO selector switch and addition of 12 vdc relay.

ceiver, so I changed the 10 pf coupling capacitor to a 100 pf capacitor, and now I have good volume on the calibrator.

Since I have been operating with the TCU it is amazing, how much more enjoyable it is to operate and how much easier it is to find a clear frequency without losing my original contact.

. . . WB2MPZ

Ham Hospitality

The idea for a Ham Hospitality list in 73 has brought many enthusiastic replies. We will list, each month, every new offer for hospitality. Please send in your name, call, address, phone number, what hospitality you are offering, and your interests. Specify if you are interested in stateside amateurs as well as DX visitors.

Buffalo, N.Y. DX OM/XYL/children, overnight/dinner, local sightseeing, rag chewing, State University. Interests: travel, photography, computers, skiing, camping, politics. Dick Eckhouse WA2CVL/W9EGY, Amherst, N.Y. 14226. 716-839-3627.

Hobart, Tasmania, Australia, OM/XYL/kids, two days. Guidance for tourism, some local sights, lots of talk. Try to come first Wednesday of month, to meet members of W.I.A. Interests: amateur electronics design, human destiny, fishing, magazine publishing. R. Leo Gunther VK7RG (ex-W6THN), 32 Waterworks Road, Dynnyrne, Tasmania 7005. Phone: 23-7670.

Dear Wayne,

My wife and I would like to appeal to 73 Magazine and its readers for some help and hospitality. We will both graduate from Iowa State University next spring and are hoping to visit Europe for three months before beginning work. Our hope is to meet with and better understand our friends' thoughts and lives in Europe.

Our method of travel will be with Eurail Pass and we plan to travel north to Norway and Sweden and south to Spain and Italy. We wish to correspond with and become friends with Europeans before we travel in the 13 countries serviced by Eurail Pass trains.

Below you will find our listing for Ham Hospitality. Thank you and may we soon have new DX friends visit us in Ames, Iowa.

Jim and Nancy Larsen WAØLPK

Washington, D.C. – Annapolis, MD Area. DX OM/XYL, overnight/dinner, local sightseeing and rag chewing. Bill Shepherd W3ZSR, 12,000 Twin Cedar Lane, Bowie, Maryland 20715. Telephone 301-262-0155.

Ames, Iowa, DX OM/XYL overnight/meals, tour Iowa State University. Interests: OM–talking, flying, music, occult. XYL–speaks French, art, sewing, computers. Jim & Nancy Larsen WAØLPK, 587 Pammel Court, Ames, Iowa 50010 (515-233-2591).

The Ball of Wax – A Calibrator

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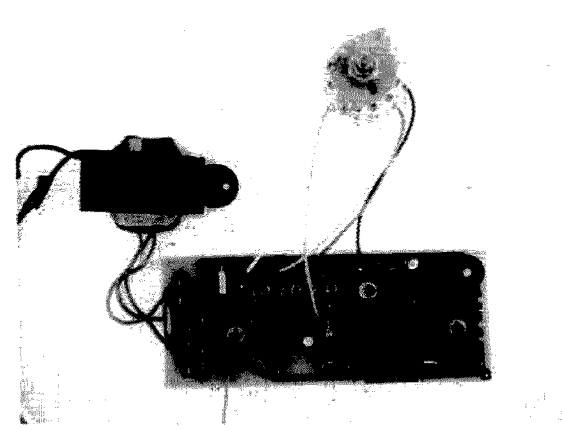
In several receiver calibrator articles in the past, the author has used bipolar transistors, emitter-coupled logic (ECL), integrated circuits, junction FET's, and resistor-transistor-logic (RTL) integrated circuits.[1,2,3] By now, the idea of integrated circuits as dividers in 100 khz and 1 mhz crystal calibrators should be pretty well established. The acceptance of ECL and RTL integrated circuits by hams and experimenters is underlined by the fact that both of these logic families are now available in Motorola's HEP line, at most any radio parts store.

The calibrator to be described here is one that uses an admixture of bipolar transistors, a junction FET, MOS-Digital IC's, an MOS-FET, and a linear IC. Such a unit could only be called a "ball of wax," because of the variety of components. We will find, however, that in spite of the differences between the various components, they compliment each other very well.

The finished calibrator provides the operator with a quite useful choice of frequency calibration marks: 200 khz, 100 khz, 50 khz, and 25 khz spaced spectrum lines. This set of calibration markers is a convenient one for use with the general-coverage type of hf receiver.

The design philosophy of this calibrator is somewhat different than most others published in recent years. Usually, the crystal oscillator is followed by a squaring circuit, and *then* by dividers, as in **Fig. 1**. This is the method used in references 1 and 2. However, in "The Ball of Wax," since MOS - IC's were used as dividers (whose uppermost counting speed is only 500 khz), the dividers were followed by a Schmitt-Trigger. This system is shown in **Fig. 2**. The Schmitt-Trigger circuit "speeds up" the waveform, assuring that the rise-time is fast enough to produce good, useable harmonics throughout the hf bands.



Finished circuit board.

The complete rf circuit of the calibrator is shown in **Fig. 3**. Although the circuit of the **Fig. 3** looks complicated, it contains less than $7.00 worth of semiconductors.

The crystal oscillator (Q1) is a Colpitts-type which operates the surplus FT241 crystal in the series-mode. Most hams are accustomed to operating FT241 crystals (of the 400 to 500 khz variety) in a parallel-mode oscillator. Apparently the 200 khz FT241 crystal is the one exception in this holder style; so operate it series-mode! The 200 khz crystal was obtained from Jan Crystals (2400 Crystal Drive, Ft. Meyers, Fla. 33901) for $1.75 plus 10¢ postage.

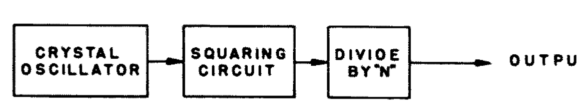


Fig. 1. Usual design circuit.

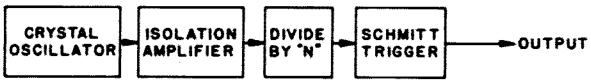


Fig. 2. Drawing of the Schmitt-Trigger system which is used to produce useable harmonics in the hf band.

Following the crystal oscillator are two isolation amplifiers, Q2 and Q3. Q2 drives the MOS-IC divider chain, and Q3 drives the Schmitt-Trigger when 200 khz output is desired. Less elaborate isolation gave small variations in crystal oscillator frequency when one switched between 200 khz and 100-khz outputs.

The "heart" of the calibrator is, of course, in the three binary dividers: Hughes HRM-F/2 MOS integrated circuits. Unlike other IC's, these are packaged in TO-18 transistor cans with four leads. With one lead for power and one for common, that leaves the other two leads for input and output. If we'd look inside the F/2, we'd probably find a complete J-K Flip-flop, as offered in more complex members of Hughes' HRM family. However, in this simplified binary, only the "T" (toggle) and "Q" (output) are brought out of the can. The HRM-F/2 will operate up to 500 khz and costs *less* than any RTL binary, (even less than half of an MC790P dual-ff). Three HRM-F/2 IC's divide the 200 khz output from Q2 down to 100 khz, 50 khz, and 25 khz.

The Schmitt-trigger is unusual in that it has an MOS-FET in its input stage. This feature is used to prevent loading the output of any of the dividers of Q3. An ordinary Schmitt-trigger, using two bipolar transistors, so heavily loads its input, that it is almost invariably driven via an emitter-follower. The use of a fast N-channel MOS-FET gets around the input loading, without sacrificing rise time.

If it is desired to operate the calibrator from its own line-operated power supply, a simple regulated supply is shown in Fig. 4. An integrated regulator made by Continental Devices Co. is used because of its low price and simplicity. The CMC 513-4 looks like any epoxy TO-5 transistor, having only 3 leads. Inside this wondrous $3.00 package are all the components to make up a regulator: transistors, resistors, voltage reference, and even a thermistor to shut down the regulator when the temperature gets too high. With a finned clip-on dissipator, the author has run these little regulators up to 100 ma. The rf circuit of the calibrator only requires 15 ma, so the CMC 513-4 is more than adequate for this job. The Philbrick/Nexus 2105 IC-regulator is apparently a

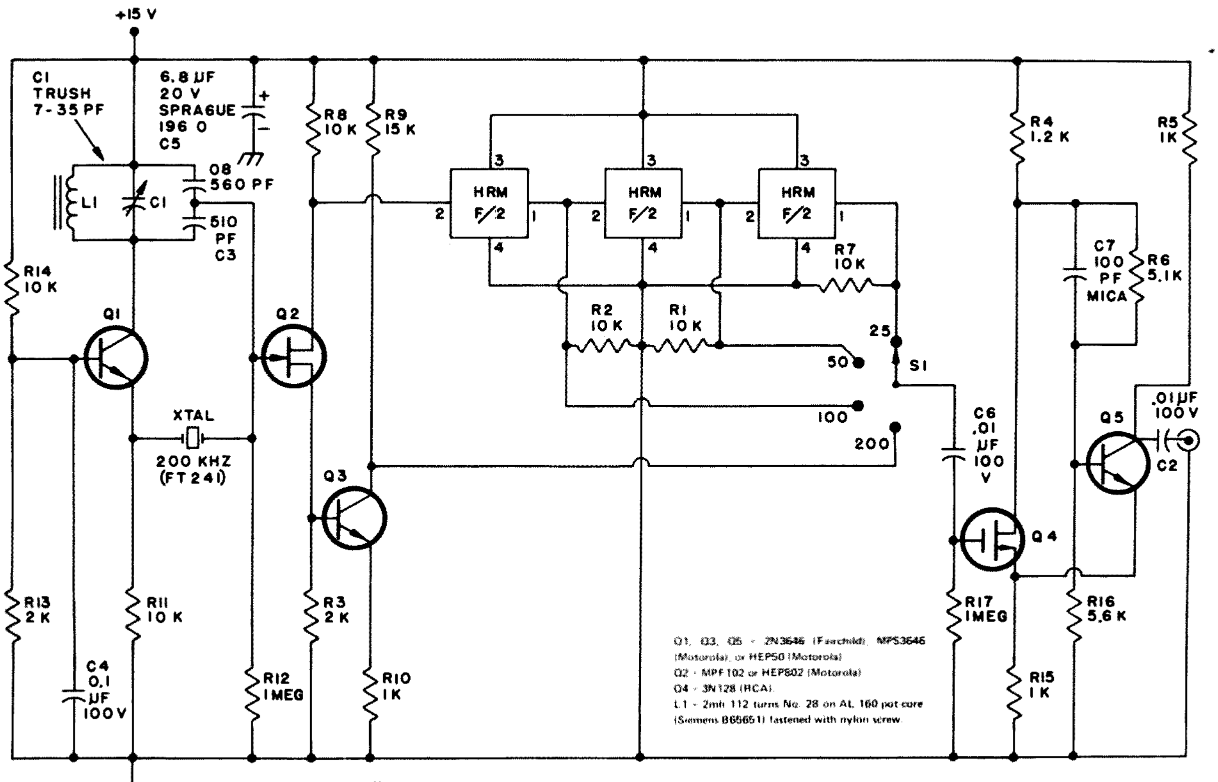


Fig. 3. Complete circuit of calibrator.

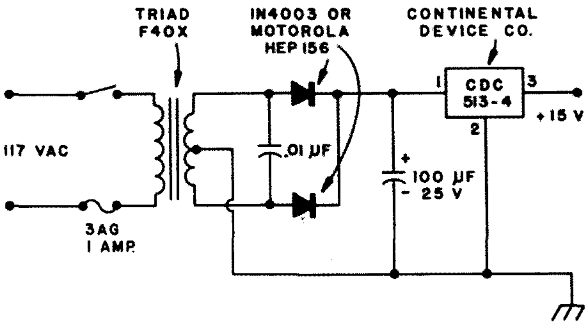


Fig. 4. A simple regulated power supply for the calibrator.

similar device (at approximately the same price), and may also work here. A Triad F40x was used for the power transformer; it is capable of considerably more output current than needed, but smaller transformers are more expensive.

It was decided to put the rf circuitry and the power supply circuitry all on one etched circuit board. Since the power supply has so few components, little space is wasted if one decides not to build that portion. The board layout is shown in Fig. 5 and the parts layout in Fig. 6.

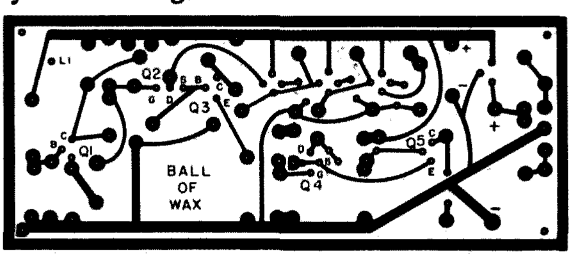


Fig. 5. Illustration of the circuit board layout.

There are a number of points about construction and materials that should be mentioned. L, was handwound using a

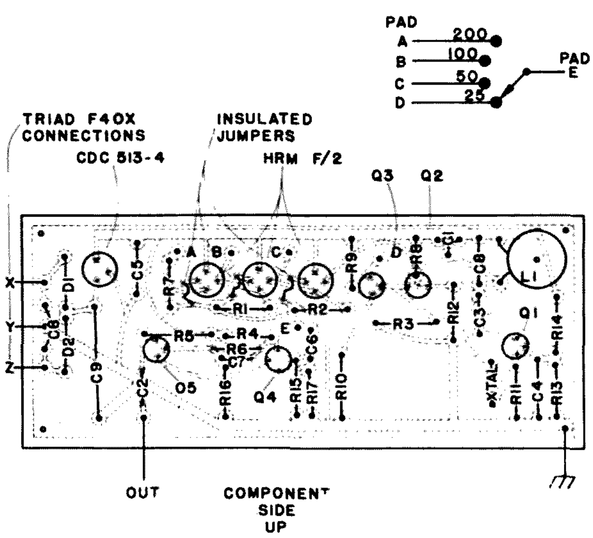


Fig. 6. Illustration of the parts layout.

Siemens B65651 pot core; the cost of two core-halves and bobbin are less than $1.60. The core was clamped together and held down on the etched circuit board with a nylon 4-40 screw. This core has an air gap in it, *thru which the screw passes*; so don't use metal screws. The AL160 printed on the core would indicate that we'd need 112 turns for 2 mh, but 112 turns is nominal. (The AL number on a core is the number of nano-henries per turn-squared we wind on that core.) The tuning capacitor, C1, is a Trush miniature ceramic type. Other types will work, but the board is laid out to fit this Trush model. The crystal socket is made from two pin-grips removed from an old octal socket. They are soldered through the board and bent 90° to accept the FT241 pins.

The procurement of parts, especially ferrites and semiconductors, may prove to be a bit more difficult than usual. The advantages offered by the modern components used in the "Ball of Wax" however, seemed to outweigh this increase in procurement difficulty. Parts procurement for the unit should certainly not be beyond anyone working in the electronic indstry. However, if one does have trouble getting parts, Stafford Electronics (427 South Benbow Rd., Greensboro, NC) is offering both etched circuit boards (Part no. ST-11-69E at $2.50) and a kit of semiconductors and i.c.'s board ($15) for "The Ball of Wax."

. . . W6GXN

References

1. Olson, H., "A 50 khz Calibrator," 73, Aug. '66, p. 42.
2. Olson, H., "The Mark 11 Calibrator," 73, Dec. '66, p. 58.
3. Olson, H., "A Frequency Calibrator for the V.H.F. Man," 73, Aug. '67, p. 12.
4. Olson, H., "Ferrites, or What's Mu with You," CQ, Apr. '66.

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters have been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

James Riff K9JSC
2101 North Neva
Chicago, IL 60635

Electronic Variac

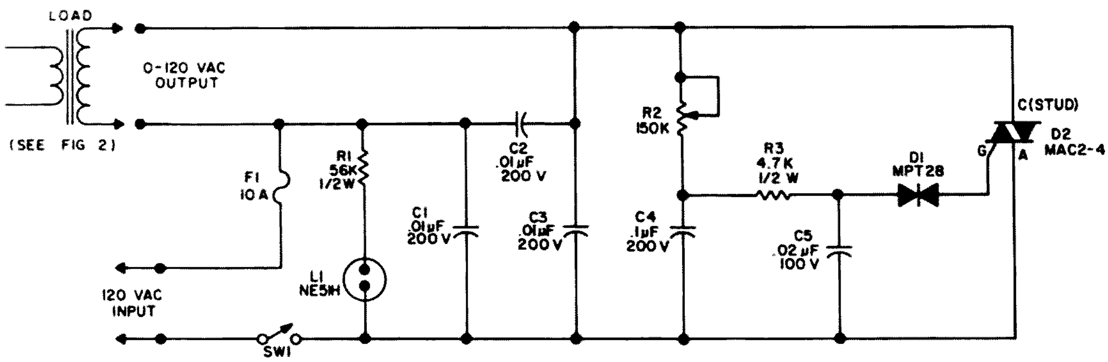


Fig. 1. Electronic Variac schematic. C1 to 3—.01uf 200V Capacitor; C4—.1uf 200V Capacitor; C5—.02uf 100V Capacitor; D1—MPT28, 3 Layer Diode (Motorola); D2—MAC2-4, 200V Triac (Motorola); F1—10 Amp Fuse; L1—NE51H Neon Lamp and Socket; R1—56K, 1/2 Watt ±10% Resistor; R2—150K Pot, Lin. Taper, 1/2 Watt; R3—4.7K, 1/2 Watt ±10%; SW1—SPST Switch, 10A; Misc.—Line Cord, Terminal Strip and Chassis.

In the realm of electronic experimentation, it becomes necessary to use a variable voltage source as a means of precision voltage control.

The Electronic Variac circuit outlined in Fig. 1 will provide a full range of voltage control for the primary of any 120 vac 60hz transformer requiring less than 10 amperes of primary current.

The Electronic Variac may be constructed in a small 3"x5" utility box, or mounted in the front panel of the controlled source. The only modification to the equipment in which the Variac is added is a single 3/8" mounting hole for the 150K pot. If an outboard system is more versatile, then a line cord and socket will be needed for ease of connection.

Construction:

Choose either of the two above mentioned mounting arrangements and begin by mounting the MAC2-4 triac to a good heat sink surface. Since this is a stud mounted device, a single ¼" hole will be needed. Apply silicon grease or IRC heat sink compound to both insulating washers and the base of the device before mounting. Check for electrical shorts between the stud and chassis after mounting the triac, for the stud carries full line potential. When connecting the MPT-28 trigger diode, be certain to heat sink the leads before soldering. The leads should be left their full length for heat dissipation. Both leads of the MPT-28 are identical and no polarity need be observed. Although the anode and cathode of the MAC2-4 are identical, the gate is the shorter of the two terminals protruding from the top of the device and it must be connected to the trigger diode MPT-28.

Addition of the on and off switch, fuse, neon lamp and capacitors CI, C2, C3 are all optional. The capacitors are installed to eliminate the rf or noise generated by the system. Experimentation with the requirements for these capacitors are left up to the individual.

Applications:

The control of many types of ac loads is within the capabilities of this simple circuit. One example is the addition of the Electronic Variac to the circuit shown in Fig. 2.

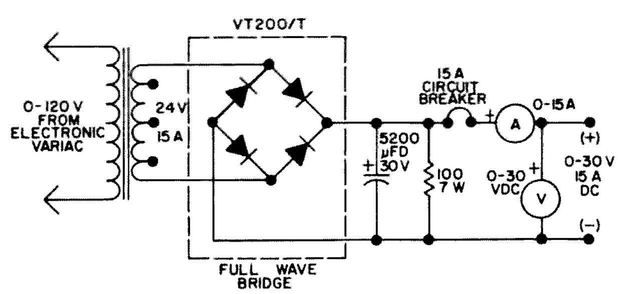


Fig. 2. DC battery eliminator/charger/power supply. C1—52000UFD, 30WV, (GE, 86F147M; CB1—15A Circuit Breaker (375-215-101 Wood Electric); D1—Full Wave Bridge, (VARO VT200/T), (or: 2-MR1120, and 2-MR1120R, Motorola); M1—0-15 Amp Ammeter (EMICO); M2—0-30 Volts dc, Voltmeter (EMICO); T1—24V 15A Filament Transformer (Knight 54F2335) or Equivalent; Misc.—Chassis, Terminal Strip, Binding Posts; R1—100Ω, 7W Wire Wound Resistor.

A battery charger or high current bench supply that is variable from 0-30 vdc is very useful in checking the mobile rig on the bench or powering bread board circuits. Fig. 2 shows a straight forward power supply using a full wave bridge if needed. A well stocked junk box should yield most of the parts required for the supply.

Other applications include a variable supply for hobby use such as electric trains or slot cars, plating of metals and light control. The Variac can be used to replace that worn out hunk of Variac in the plate supply of your high power rig. The Electronic Variac is small, produces little heat and for less than $8.00 worth of parts, does the job of a large variable transformer costing more than three times as much.

. . . K9JSC

Ham Hospitality

If your home is open to visiting hams, please send a note to 73, Peterborough, NH 03458, giving your name, call, address, phone, hospitality offered and whether to DX or U. S. hams. You are missing one of the finest aspects of amateur radio if you are not being visited now and then by DX operators.

SB-33 Modification

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Titusville, FL 32780

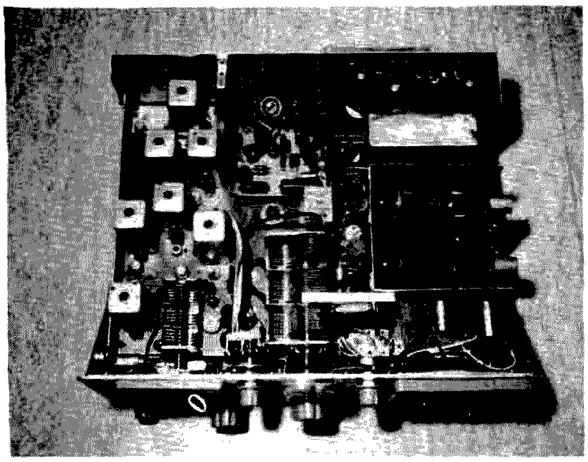
When the time came to purchase a SSB transceiver, the SB-33 was chosen. It is compact, solid state and the price had just been reduced when the new SB-34 was released.

After several months of operating it was decided to try to improve the performance and increase the flexibility of the transceiver.

The first item added was a 100 khz calibrator, shown in **Fig. 1.** The crystal oscillator was taken from an earlier GE transistor manual, but the harmonics did not have sufficient amplitude, so the amplifier stage was added. This provided more than enough harmonic output and even produced outputs in excess of 100 mhz when checked on a Nems-Clarke receiver. By using an amplifier transistor with a higher ft than the 2N2189 I am sure output would be sufficient for 100 khz markers on two meters.

The calibrator was assembled on an epoxy board and put in a 3¼ x 2 x 1 inch Minibox which was attached to the back of the transceiver. A switch was installed on the side of the Minibox to control calibrator operation and the 10 volts needed to operate was obtained from the transceiver.

As far as the receiver was concerned, the next items the author felt needed improvement were the sensitivity, especially on 15 and 20 meters, the overload characteristics and a quicker acting agc at normal volume settings was desirable. The rf amplifier transistor Q12 was replaced with the mixer transistor a 2N2495. According to the data sheet, the 2N2495 noise figure is 2 db up to approximately 25 mhz which is probably lower than really needed for hf. The transistor used for the mixer Q11 was a 2N2672 which was taken out of the original rf stage. Other hf transistors checked in the mixer stage include a 2N502, TIXM10 and a 2N1742, but they had too much gain and



Top view of modified transceiver. The two added crystals Y7 & Y8 are visible in the lower left on either side of the vfo capacitor shaft, lower right of photo shows the compressor/preamp on top of speaker. The two front panel mounted toggle switches are seen on either side of the bandswitch knob. In the upper right of the photo are seen the added 300uf capacitor and part of the minibox containing the 100 khz calibrator.

the receiver would overload at lower signal levels than with the 2N2672. No bias changes were made in either stage.

With the volume at comfortable room listening levels it was felt the agc should start at lower signal inputs so the 10K ohm agc feedback resistor was changed to a value of 4.7K. SBE used a 6.8K resistor in the SB-34, but the 4.7K performed better.

If the audio gain is operated higher such as in mobile use it may be desirable to use a somewhat larger value than the 4.7K ohms. The receiver is now more pleasant to tune with the agc holding the audio output at a more constant level.

To further minimize cross modulation or overload, a 12 db pad was inserted between the receiver and the antenna relay as shown in **Fig.** 2 and a switch to insert it or remove it from the line was mounted on the back panel next to the antenna connector. Adding in the pad sometimes helps the copy of signals when strong signals are adjacent in frequency, especially on 40 meters at night.

In an effort to increase the gain of the receiver so that the volume control could be operated at a lower level, it was desired to have more *if* gain and audio gain. The collector load resistor of Q5 was changed from 1K ohm to 3.3K ohm, which SBE does in the SB-34. Q7, the receiver *if* amplifier transistor, was replaced with a 2N1224 which provided more gain at the same volume setting than the 2N2672 used originally. Now with the greater amplification in *if* and audio stages the volume control does not have to be advanced as far for a specified audio output. By operating the volume control at a lower setting the amplification of the hf mixer, Q11 is held to as low a value as possible which helps to prevent overload of the vfo mixer and *if* amplifier.

The proof of the pudding is in the testing so the receiver was subjected to the following tests in both the modified and unmodified condition: in the original configuration it took a cw signal level of .7 microvolt to produce an audio output at the speaker terminals 10 db above noise. After modification a .35 microvolt signal produced an output 10 db above noise. This test was performed on 15 meters and the rf stage was repeaked for each configuration.

To test overload characteristics, a cw signal of 5 microvolts was fed into the receiver at 21.3 mhz, another generator was set at 21.35 mhz and the output increased until the audio output from the 5 microvolt signal decreased by 6 db. In the unmodified state a signal level of 9.5 millivolts at 21.35 mhz was required to reduce the desired 21.3 mhz signal output by 6 db. After modification a 13 millivolt signal was required at 21.35 mhz to reduce the 21.3 mhz signal by 6 db. The better overload rejection can be attributed to the increased gain in the *if* and audio sections, which allow lower gain control settings.

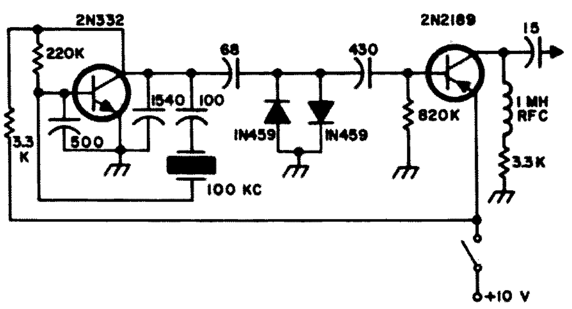


Fig. 1. Schematic of 100 khz calibrator. Parts values are not critical and the transistors do not have to be the ones listed. It is suggested that a late version of the GE transistor manual be consulted for a slightly revised oscillator circuit.

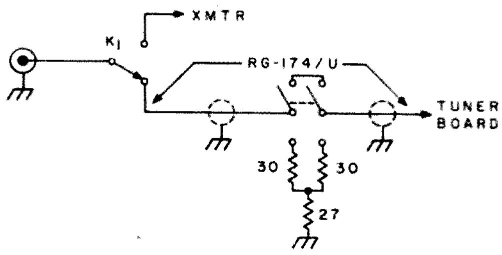


Fig. 2. Schematic of 12 db attenuator added to receiver. Small RG 174/u coax was also added between relay K1 and the tuner board as shown.

The above tests were conducted using HP-608 generators and a HP-3400 rms voltmeter. Output level at the speaker was maintained at .1 volt rms with signal and the agc transistor, Q19, was removed to disable the agc.

The first change in the transmitter was the high voltage supply. It was noticed that under 250 milliampere load the B+ voltage dropped to 385 volts from about 470 at 80 ma. To remedy this a 300 mf 150 volt capacitor was used to replace the 100 mf 150 volt unit in the voltage tripler supply. Even though the 300 mf capacitor is larger than the 100 mf unit, it fits quite well in the allotted space. Be sure to use small heat sinks on the diode leads when soldering the capacitors. After the modification, the high voltage at a current of 250 ma was 445 volts. Although this change yields a minimal power gain it is felt that the better regulation provided is worth the change.

In an effort to use a high impedance microphone with the transceiver (the author did not have a low impedance microphone), a preamp was needed. Since a preamp had to be constructed, it was decided to combine it into a speech compressor. The preamp/compressor was built on a 1 3/8 x 2 5/8 inch epoxy board and mounted on top of the speaker coil. A switch was added on the front panel to change the amount of compression.

To be able to operate in the cw portion of the bands additional crystals were added

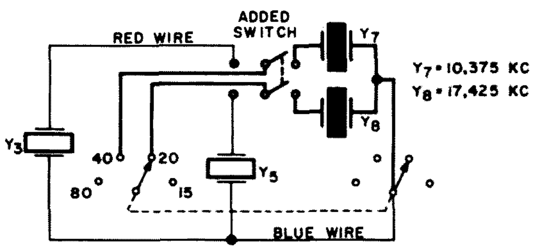


Fig. 3. Circuit showing the additions of crystals Y7 and Y8 for CW coverage on 20 and 40 meters. The added components are shown by heavy lines.

in the hf oscillator. For 20 meters a 17,425 khz crystal and for 40 meters a 10,375 khz crystal were used to cover the cw portions. They are type HC-17/U crystals installed in two crystal holders mounted to the chassis lip behind the lower portion of the tuning dial. The crystals are switched by a simple DPDT miniature toggle switch mounted to the left of the mike jack on the front panel. A schematic of the changed circuit is shown in Fig. 3. If one wishes to cover all four bands on cw, a miniature four-pole double-throw rotary switch could be used with the additional crystals. To keep front panel appearance the switches might be mounted on the rear panel. To key the transceiver, a circuit as shown in the February, 1966, 73 could be fabricated on a board and installed on the back of the 33 near the *if* section. This has not been accomplished by the author, but will be forth-coming in the near future.

Additional changes in the original transceiver were to add a single hole SO-239 uhf connector in place of the original antenna connector and another change was to move the tuning dial pilot light further forward away from the vfo circuitry. When the transceiver is buttoned up tight, the pilot light does give off some heat. An alternate method might be to dim the pilot lights by using a dropping resistor. A three-amp fuse was also added; although the schematic showed a fuse, there was none in the unit.

Well, there it is, a good transceiver made a bit better. Most of the changes can be made without altering the physical appearance of the transceiver and the rest require only minimal changes, most of which could be removed later if desired.

. . . W4MNW

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Call Letter Lunacy

When Hubert H. Humphrey lost the election, gloom clouded the airwaves of radio station WHHH in Warren, Ohio. They didn't support this staunch democrat, but the president's initials in their call sign would have given the station prestige. Richard M. Nixon won, and WRMN in Elgin, Illinois, celebrated. KFDR in Grand Coulee, Washington, also gained some fleeting recognition when Franklin D. Roosevelt was in office.

These are only a few examples of the 4,224 standard (AM) radio stations in the United States that have distinguishing and sometimes, meaningful, call signs. Referred to as "license plates" of the air, they identify the nationality of the station, the type of station, and the individual station. Since 1927, under international agreement, the alphabet has been used by the countries of the world for radio identification. The United States is assigned the letters K, W, and N. The Navy and Coast Guard employ the letter N. K is used for those stations west of the Missippi River, while those beginning with W are east of the river. A few stations such as KDKA in Pittsburgh received their call letters before this plan was adopted.

The Federal Communications Commission, through the Communications Act, is responsible for allocating call letters to all radio stations in this country, with a few military exceptions. Stations have the privilege of requesting particular call signs other than the first letter. If a new broadcasting station makes no specific request, it is assigned appropriate letters. Amateur call signs are also assigned from unused letters.

Most radio stations prefer call letters consisting of letter combinations which specify the station's location or some aspect of the broadcasting area. The best and simplest call letters include the name of the broadcasting city or town. There is immediate identification with KADA in Ada, Oklahoma; KELY in Ely, Nevada; WACQ in Waco, Texas; and WARE in Ware, Mass. KAYS in Hays, Kansas, and KODI in Cody, Wyoming, are allowed some literary leeway. Cities with long names must use abbreviations in their call letters. This is exemplified by KANA in Anaconda, Montana; KAST in Astoria, Oregon; and KIND in Independence, Missouri. The latter also indicates a very friendly city.

The weather plays an important role in selecting a radio station's letters. Citizens of cold climates such as Aspen, Colorado, shiver to KSNO while those in Barre, Vermont, hail WSNO. The winter resort of Sun Valley, Idaho, supports KSKI, while WSKI is located in Montpelier, Vermont. Warm weather is wonderful to KSUN in Bisbee, Arizona; KTAN in Tucson, Arizona; KHOT in Madera, California; WSOL in Tampa, Florida; WSUN in St. Petersburg, Florida; and WTAN in Clearwater, Florida. In Ocean City, Maryland, everybody gets WETT, while the breezy city of Chicago has WIND. Ironically, it's KOLD in Tuscon, Arizona; KOOL in Phoenix, Arizona; and WARM in Scranton, Pennsylvania. It could be said that these radio stations are very "unsound."

The agricultural products of a region are represented by its call letters. Cattle country caters to KALF in Mesa, Arizona; and KCOW in Alliance, Nebraska; while Mitchell, South Dakota residents hear KORN. Visitors to Farmville, North Caro-

lina, curiously contemplate WFAG. However, a fag is a British term for cigarette and North Carolina is the leading producer of tobacco. Idaho, known as the gem state, naturally has KGEM in Boise. KAVE echoes in Carlsbad, New Mexico, which is noted for its mammouth caverns. Hawaii is famous for the hula and poi, a native food prepared from the taro root and allowed to ferment. Honolulu is proud of KPOI and KULA.

Las Vegas, Nevada, is the city of chance, with gambling a prominent pastime. The glamorous atmosphere permeates into radio with KLAS, KLUC, and KENO. Keno is also a form of lotto used in gambling. Another Las Vegas in New Mexico wants part of the action and promotes KFUN.

There must be considerable confusion in Easton, Pennsylvania, with WEST. How do they stay awake at WZZZ in Boynton Beach, Florida? Are things really green in Greenville, Missipi, with WDDT?

Some radio stations are quite hip. They WSOK it to you in Savannah, Georgia, and WSOC it to you in Charlotte, North Carolina. One of the "highest" rated stations in the country is WLSD at Big Stone Gap, Vermont. Do they also have a generation gap there?

The FCC frowns on pornography and tries to keep the airwaves clean. They overlooked KIZZ in El Paso, Texas; KKIS is Pittsburg, California; and KXXX in Colby, Kansas. In staid, stoic, Salt Lake City, Utah, founded by the Mormons, one can listen to KSXX, but only if you're twenty-one.

. . . Philip Moshcovitz

"Old soldiers never die — young ones do."

Assistant Editor Opening

Somehow, working doesn't seem that much like work when it is in your hobby. We have a fun bunch of people here at 73, for the most part, and we need someone to help with the technical editing, testing of new equipment, and about 8000 (plus or minus a half dozen or so) jobs. New Hampshire is one of the most wonderful places in the world to live, with an incredibly varied climate and beauty. Requirements? A good solid knowledge of radio, and English, and a convivial personality. Here is an opportunity to help make 70,000 plus readers of 73 get a little more enjoyment every month. What can you find to do that will be better than that? Salary? That depends on your background and ability. I think we are paying the highest salaries in the ham publishing field even though we live in a low rent district.

Antenna Interaction – What to Do About It

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If you have an antenna farm (and who doesn't nowadays?) you may have wondered what effect your unused antennas may have on antenna performance. I too had thoughts about those unused radiators, when one day I noticed that a quarter wave grounded vertical produced a half ampere of antenna current while the transmitter was on the inverted V! Receiving tests showed very noticeable changes in S-meter readings as various antennas were grounded and ungrounded at random. Other tests also revealed that transmitter loading varied as other antennas were grounded and ungrounded. The more I experimented, the more confused I became, so I concluded that these haphazard tests had gone far enough.

Since the interaction seemed to be most severe at the fundamental frequencies, the question was basically whether to ground or not to ground the offending antenna. With the assistance of the trusty grid dipper, all antenna systems were checked for resonant frequencies, both in the grounded and ungrounded state, as shown in the illustration. The beam was also checked with the end of the feed line shorted out. Very often a ten or twenty meter beam with its feed line will resonate on forty or eighty meters as a half wave or quarter antenna.

After tabulating the grid dipper findings, it should be easy to check on potential absorbing frequencies. The procedure is simple. Carefully load the transmitter at the frequency of interest and alternately ground and unground all unused antenna systems

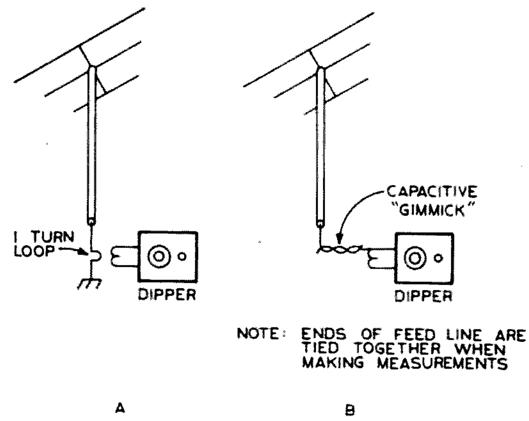

Fig. 1. A)Antenna checked in a grounded state. B)Antenna checked in a non-grounded state.

one at a time. If this affects transmitter loading appreciable (more than five or ten percent change in final plate current) check the unused antenna further by touching a neon bulb to the end of the shorted feed line in the shack. If the bulb lights, it is an indication that the antenna system is absorbing power as a half wave antenna and should be grounded to move the resonant frequency out of the band. On the other hand, if transmitter loading is excessive with the antenna grounded, it is an indication that the antenna system is absorbing energy as a quarter wave antenna, and should accordingly be left ungrounded to move the resonant frequency out of the band.

In other words, all unused antenna systems will act either as half wave or quarter wave absorbers, depending upon whether or not they are grounded. The trick is to set up the antenna system so that its

resonant frequency is always outside the band you are working.

Occasionally you may run into a situation where an unused antenna absorbs power whether it is grounded or ungrounded. This can happen particularly on the higher frequency bands such as 10 or 15 meters, the offending antenna usually being a 160 or 75 meter antenna. However, in cases where this has happened, the effect on transmitter plate loading has been negligible.

It has been generally found that antenna interaction is at its worst on the lower frequencies from 160 meters through 40 meters. In one instance the interaction was so severe that final loading was always excessive and could not be reduced by the usual turning procedures. In another case, full loading could not be attained with any adjustment of the final. Both of these, of course, were extreme cases. However, if you have two or more antennas, interaction can be a problem which a little thought and experimentation will reduce to negligible proportions in almost every situation.

. . . W6FPO

Keyboards for Keyers

The amateur press has carried several articles on building keyers that work from a keyboard, like a typewriter or a Teletype, instead of a paddle or knob. Such devices can be bought, but few amateurs would want to pay the cost. Besides, it's much more fun to build something.

Building a keyboard type keyer has one time-consuming, as well as non-interesting (from the electronic viewpoint), portion. That's the keyboard itself. Fortunately, the ambitious builder has at least three sources from which he can buy such an item.

A simple make-and-break preassembled keyboard can be bought from Nutronics, Box 72, Paramus, NJ 07652. It's only one inch deep, has a throw of 0.1 inch, and needs only three to five ounces pressure to make a firm contact. Also, they're designed to be compatible with printed circuit building techniques.

Going to a bit more exotic practices, there's one that uses magnetically controlled solid-state "contacts"; these should never wear out! If you're interested, you can get more information from NPC Electronics, 3133 East 12th Street, Los Angeles, CA 90023.

For the top in sophistication, you'll want a keyboard that actuates by proximity. This is an infinite-life device, guaranteed for 100% reliability. The whole structure is 15-7/8 inches wide, 8 inches deep, and 3½ inches high; it weighs 12 pounds. This one is marketed by Transducer Systems, Inc., Easton and Wyandotte Roads, Willow Grove, PA 19090.

Carl Drumeller W5JJ

"He who knows but little presently outs with it."

Getting Your Extra Class License

STAFF

Part X-Sidebands

In our last session of this study course, we examined the commonly-used types of modulation—with a couple of very major exceptions. We completely passed by SSB and DSB techniques, for the reason that they are sufficiently detailed to deserve a complete installment in themselves.

So this time, let's continue with modulation, and concentrate on sidebands.

In so doing, we will cover only four questions from the official FCC study list—but those four questions are most comprehensive ones indeed:

9. Describe briefly the basic sections of a single sideband transmitter. In what section of a properly operating SSB transmitting system is distortion most likely to originate? In what section is non-linearity most likely to originate?

14. How can the two-tone test output of a linear amplifier be used to tell if a transmitter is working properly? Show scope patterns for optimum, overdriven, and underdriven amplifier conditions.

20. How would the reception of a single sideband signal be affected if the carrier is not completely suppressed? How can spurious signals in the output of the mixer stage of an SSB transmitter be suppressed?

21. How does the beat frequency oscillator affect the tuning of a single sideband signal?

Following our usual practice, we won't attempt to answer these questions directly and specifically. Instead, we shall substitute four other questions of broader scope—and our exploration of the answers to these broader questions will, we hope, include the answers to the FCC questions as well as to similar questions not on the study list.

In order to have single sideband communications, we must generate a SSB signal, and we must receive it. If it has any faults, we must be able to meausre them—but before we can measure them, we must have some notion of what we're looking for.

This list provides us our four broad questions: "How can we generate SSB?", "What faults mar SSB signals?", "How is SSB quality measured?", and finally "How does the receiver affect SSB?"

At this stage it would be well to note that any attempt to provide exhaustive discussion of even one of these questions would—and has—filled large books. In this study course, we can only try to provide a way of looking at the answers together with enough meat to enable you to start studying for yourself. We may, at times, oversimplify in our efforts to meet this goal. For complete authority, check the references listed in the bibliography at the end of this installment.

Having made our disclaimer, let's get on with the business at hand:

How Can We Generate SSB? We saw in our previous installment that a conventional AM signal involves the mixing of the audio frequency voice signal and the rf carrier signal to produce not only the original pair of frequencies, but new sum and difference frequencies known as sidebands. One, the upper sideband, is made up of the *sum* of the audio frequency signal components and the carrier; one way to think of it is as an rf signal made up of as many frequencies as there were in the af signal, in which each rf-signal component's frequency is equal to the carrier frequency *plus* the audio component's frequency.

The other, or lower, sideband is identical

except that its frequencies are determined by *subtracting* the audio-component's frequency from the carrier frequency.

Because the carrier frequency is constant, this means that each sideband is an audio signal which has been converted to a radio frequency. The lower-sideband signal is inverted; that is, the low tones of the audio become higher radio frequencies than do the high tones of the audio. The upper-sideband signal, on the other hand, is not inverted; its low and high tones bear the same absolute relationship to each other at rf that they do in the af original.

If we generate a conventional AM signal, and then by some magical means strip away from it the carrier and one of the two sidebands, what we have remaining is only a single sideband. Such a signal is known as a single sideband signal, abbreviated SSB, and the first SSB was generated in just that fashion—at very low radio frequencies (approximately 27 khz to be specific). Today's SSB is generated a little differently—and that's what our question deals with. First, though, let's look at SSB characteristics.

The characteristics of SSB are, on the surface at least, quite different from those of conventional AM. It takes less power to produce a signal of equivalent strength using SSB, and despite the lack of the second sideband, SSB appears to be more effective under crowded band conditions.

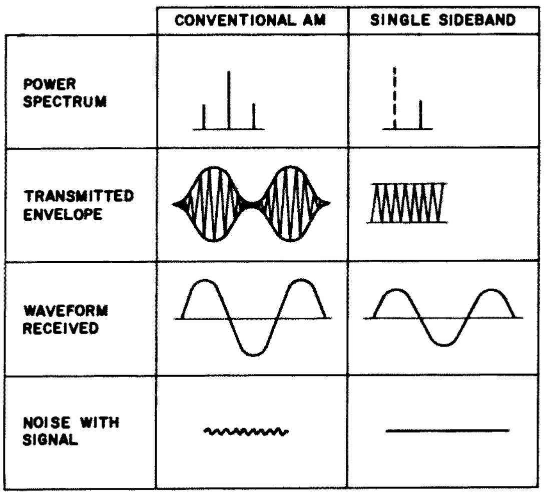

Fig. 1 Comparison of conventional AM and SSB for equal carrier strength, showing power spectrum of transmitted signal, signal envelope as transmitted, waveform recovered at receiver, and noise accompanying received signal.

A comparison of the power distribution in the signals produced at the transmitter, recovered at the receiver, and the final signal-to-noise ratio appears in Fig. 1.

The top pair of illustrations in Fig. 1 shows the power spectrum for AM, at left, and SSB, at right, drawn for the case of equivalent carrier power (the suppressed carrier of the SSB signal is shown as a dotted line). You can see that using SSB means that *all* the power is concentrated in the sideband, while AM splits the information power between two sidebands and puts most of the power into the carrier, which carries no information.

The envelope waveforms of the two signals appear on the second line. The single-frequency rf signal produced by the SSB transmitter appears much weaker than does the AM signal.

However, the third line indicates the audio voltage developed in the receiver. The carrier power in the AM case contributes nothing to this waveform; AM is stronger because the contributions of the two sidebands reinforce each other at the detector, but the actual difference is only 3 db.

And the final line, showing noise voltage, gets that 3 db back. The SSB signal needs only half the bandwidth and so permits only half the noise power to enter.

The net result is that in these two comparison cases, SSB and AM produce the same signal-to-noise ratio at the receiver but the SSB signal started with only half the power (only a third as much power, if the total sideband-plus-carrier power of the AM signal is compared to the single sideband power level). For equivalent power at the start, then, the SSB system would produce a stronger signal at the receiver.

The signal is not only stronger, it's clearer too (with proper receiver design and operation). Fig. 2 shows why; this illustration shows what happens to conventional AM signals when they encounter selective fading—a normal event during any skip contacts. If the sidebands fade and the carrier does not, the audio power goes down as shown in the left column. If the carrier's phase is shifted relative to the sidebands, again audio power goes down as shown in the right column. Worst of all, though, is

when the carrier fades and the sidebands (or at least one sideband) remain steady. The resulting distortion, shown in the center column, resembles overmodulation but is

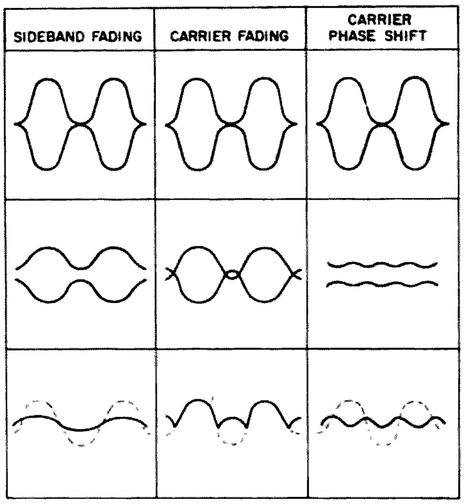

Fig. 2 Effects of selective fading on conventional AM signal. Upper row of waveforms shows envelope as transmitted; it is identical in all three cases. Middle row shows envelope as received under different types of selective-fade conditions. Bottom row shows waveforms recovered from received envelopes; dotted waveforms show what *should* be recovered. Note especially effect of carrier fading when sidebands are unaffected (center column).

much harder to understand.

A SSB signal, consisting of only the one sideband, is much less affected by selective fading. While one component can fade with respect to others, the effect is almost unnoticeable.

Now that we're convinced that SSB is a good thing, let's see how we can generate some. **Fig. 3** is a block diagram at the most basic level of a SSB transmitter. As you can see, it is composed of three major sections–the SSB generator, the frequency selection circuits, and the power amplifiers.

We'll go into all three in more detail a bit later; right now we just want to get the big picture in view. The purpose of the SSB generator is to produce a single sideband signal; it may be at final output frequency or not, depending upon our particular transmitter's design. The SSB signal may be produced in any of several ways, although two methods are by far the most popular. Once originated by the SSB generator part of the transmitter, the signal must be brought to final output frequency by the frequency selection circuits. This part of the rig includes any VFO, frequency synthesizer, and mixers which may be present. It takes in a SSB signal of some freuqency, and turns out an equivalent SSB signal at the desired operating frequency.

The operating-frequency SSB signal is then brought up to the desired power level by the power amplifiers, which may be anything from a micro-powered transistor amplifier up to a 2-KW PEP cannon, depending upon your tastes and your pocketbook.

The power amplifier's only job is to bring the signal up to the level you want for application to the antenna; they are not supposed to add anything new to the signal. Unfortunately, many amplifiers *do* add their own contributions; eliminating these distortion products is one of the major causes of premature graying among SSB operators!

With some idea of where the various parts fit into the overall transmitter functioning, let's turn our attention to the block labelled "SSB generator" in **Fig. 3** and find out what can go in that space.

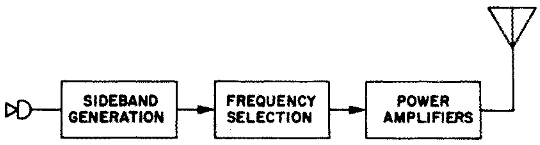

Fig. 3. Most basic block diagram of SSB transmitter; no matter what type of SSB circuitry is being used any SSB rig includes these three major sections. All are subject to wide variation, however.

While a number of methods may be used to generate SSB, the two basic systems in general use are the "filter" technique shown in **Fig. 4** and the "phasing" approach diagrammed in **Fig. 5**.

The filter technique uses a band-pass filter which has extreme selectivity to slice off one sideband, and pass the other. Such filters were originally constructed only for very low frequencies. The first generally used by amateurs, operated at a suppressed-carrier frequency of 17 khz. With development of the filter art, sideband filters are now available for frequencies as high as 9 mhz.

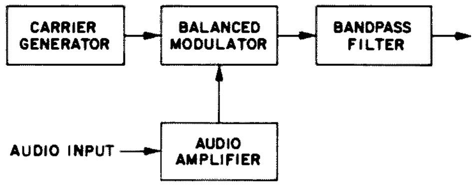

Fig. 4. Filter technique for generation of single sideband signal. Carrier generator produces rf at single, fixed frequency. Balanced modulator produces both sidebands but suppresses carrier. Narrow bandpass filter then shaves off undesired sideband, producing output signal which contains only one sideband and no carrier.

Regardless of the filter frequency, a major characteristic of the filter technique is that the SSB signal is originally generated at a single, fixed frequency, because the frequency of the filter cannot be readily varied. Subsequent stages of the transmitter then convert this fixed-frequency SSB signal to the desired operating frequency.

Starting point for the filter technique, then, is a fixed-frequency carrier generator. This rf carrier is applied, together with the audio signal, to a balanced modulator. The balanced modulator, unlike a conventional AM modulator, produces *only* the sum and

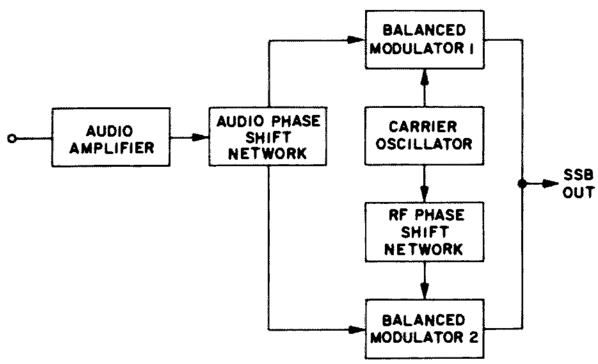

Fig. 5. Phasing approach to generation of SSB signal. Audio is frequency-limited and then split into two channels which are 90° apart in phase. A carrier frequency is generated and similarly split into two channels each 90° away from the other. Audio and rf are combined separately by a pair of balanced modulators. Resulting phase relationships between DSB outputs of balanced modulators are that one sideband is in same phase in both outputs, while other sideband is 180° away (in one output) from same sideband in other output. Summing the outputs causes the in-phase sideband to reinforce itself while the out-of-phase sideband cancels itself out.

some otherwise pretty odd-looking frequencies as those on which fixed-frequency SSB signals are generated.

The thing to be avoided, if at all possible, is what is known as an "integral relationship" between signal and mixing frequencies; this is a ratio of whole numbers, such as 3/2 or 7/3 between the two frequencies at any point in the desired operating range. If such a relationship cannot be avoided, the next best thing is to pick one involving as large numbers as possible, which means that the harmonics which might cause trouble would have to be much higher than mere second or third order.

Then, to hold down the possibility of spurious signals being generated, the mixers should be operated in such a manner as to create as few harmonics as possible. In general, this means a mixing circuit similar to the product detector, which minimizes intermodulation distortion. Finally, the output tuned circuits should be as selective as is practical, to reduce harmonics.

Experience has shown that the fewest spurious signals are generated when the sideband signal's amplitude is kept to a minimum, compared with the injection-frequency signal. In general, the SSB signal should be kept small until it is completely generated, on the final output frequency. Then it can be built up as desired by linear amplifiers. Any attempts to economize by running the early stages of a transmitter near their operating limits may backfire by introducing spurious signals, distortion, and non-linearity.

Besides the mixer or mixers, the frequency selection circuits of the transmitter contain the injection-frequency oscillator, which produces the signal which mixes with the SSB signal to produce the output-frequency signal. This oscillator has at least one special requirement—stability.

An SSB signal's frequency must remain constant in order for it to be received; experiments have shown that a frequency shift of as little as 20 hz is detectable, 50 hz is enough to make a voice difficult to recognize, and a 100 hz shift in frequency will turn a bass into a soprano (or vice versa).

The fixed carrier frequency used in the SSB generator is usually crystal-controlled, and care is taken to keep its frequency stable. Equal care is necessary with the injection-frequency oscillator in the frequency-selection circuits.

Normal technique is to make the single variable oscillator in the frequency selection circuits operate at relatively low frequency, and use one of several exceptionally stable designs for this circuit. Any other frequency changing necessary is accomplished by multiple mixer stages, as in double-conversion receivers.

With the signal brought to the desired operating frequency, all that's left to do is to bring its power level up to however much we may desire. That's the job of the power amplifiers.

The only essential difference between SSB linear power amplifiers and hi-fi audio amplifiers is that the SSB amplifiers use tuned resonant circuits for coupling while the audio amplifiers use high-quality transformers. Operating conditions for the tubes, power driving requirements, and power output capabilities are essentially the same in both classes of service. Hi-fi audio amplifiers have been around for many years, and it might seem a bit surprising that SSB linear amplifiers should present any difficulties—but the fact remains that most if not all of the distortion and non-linearity problems associated with bad SSB signals arises in the power amplifier stages.

One of the most major problems, perhaps not so surprisingly, stems form the all-too-human desire to get just a little bit more for one's money. In using a linear amplifier, this amounts to driving it just a little bit harder in an effort to squeeze another db or so out at the antenna.

This is a particularly insiduous problem, because if the operator is in the habit of judging his output power from the flickering of the final amp's plate meter, he will see the meter rise higher when he increases the drive.

What he won't see on the meter is the fact that the added power he gets is almost all in the form of distortion products!

We'll go into this in a little more detail a little later, when we look at some ways of judging signal quality and power output

which are more revealing than merely using the plate meter.

Back in the second installment of this Extra Class study course we examined the theory of amplifiers in some detail. In the process of doing so we looked at the way in which the "class" (A, B, or C) of amplifier operation was determined, and saw how an input signal could be distorted whenever it swung past the established operating limits of the particular circuit.

SSB power amplifiers come in many different types, but one of the most popular variety these days is that known as "class AB1". Such an amplifier is set up with operating conditions partway between pure class A (in which average plate current is steady regardless of signal) and pure class B (in which the tube permits current to flow during only half of the signal cycle), and the suffix "1" indicates that grid current is never permitted to flow.

A Class AB1 circuit requires virtually no driving power; only a voltage swing at its grid is necessary. Many tubes have been designed specifically to operate at rf in this class of service, and to have low distortion when doing so.

The fact that grid current never flows in a properly operating and properly driven Class AB1 linear amplifier has been used by several circuit designers to include an automatic servomechanism known as ALC or "automatic load control", which prevents

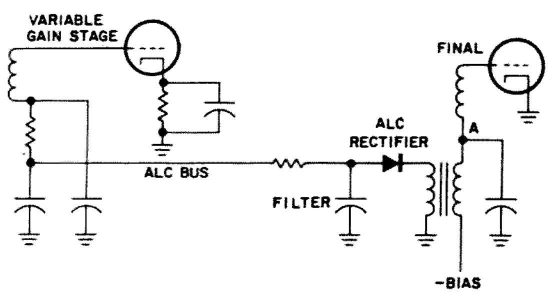

Fig. 6. How alc circuits operate; whenever final amplifier stage draws grid current, grid and cathode act as diode detector and produce a "hash" signal at point A. This AC hash is isolated by the transformer (most actual circuits use an RC tap-off instead), then rectified into negative-going DC to control gain of some earlier stage in the transmitter. Reduced gain removes excessive drive to final, which causes hash to disappear. This servo action maintains final drive at the maximum *usuable* level while preventing overload.

difference frequencies in its output. The two original input frequencies (the carrier and the audio) balance themselves out within the modulator circuit, so that carrier suppression occurs within the modulator.

Output of the balanced modulator, then, consists only of the two sidebands. The filter passes one of them and rejects the other. The resulting single-sideband signal is then ready to be applied to the frequency selection circuits.

Somewhat more sophisticated in its theory of operation is the phasing approach; this technique involves the introduction of differential phase shifts into otherwise-identical signals so that one sideband cancels itself out while the other is reinforced.

For the phasing approach, the audio must first be frequency-limited (this step is not necessary in the filter technique, because the sharp filter will itself trim the signal's bandwidth to the 3 khz voice-quality minimum). After its bandwidth is limited, the audio signal goes through a phase-shift network which produces a pair of output audio signals which are 90° apart in phase at all times.

Each of these signals is applied to its own balanced modulator. The rf for the balanced modulators comes from a carrier generator, which may operate on any frequency. One balanced modulator gets its rf direct from the carrier generator, while the rf applied to the other is shifted 90° in phase on the way.

The result is that we obtain at the outputs of the two balanced modulators, two sets of double-sideband signals, but because of the separate phase shifts applied to the audio and the rf signals the phase relationships between sidebands are rather unusual. Depending upon the direction of the phase shifts, either the upper or the lower sideband outputs of both balanced modulators will be in phase. If the upper sideband outputs are *in* phase, the lower sideband outputs will be exactly 180° *out* of phase, and vice versa. This means that we can cancel out either sideband just by combining the outputs of the two balanced modulators.

While in theory, at least, the carrier can be at any frequency, in practice phasing exciters are usually designed to operate at a fixed frequency and the resulting SSB output is converted to the desired output frequency by mixers, just as when using the filter technique. The most popular such fixed frequency is 9 mhz—chosen because it permits a single mixing oscillator in the 5 mhz range to produce either a sum frequency output around 14 mhz or a difference frequency output in the 75-meter band.

Both the filter and the phasing techniques have their own peculiar advantages and disadvantages. Through the years popular opinion has tended to elevate the filter technique, and it's certain that a filter rig requires less adjustment to keep it going if a high-quality filter is employed. Phasing, on the other hand, simply because it does offer more possible adjustments, may make it easier to compensate for component aging. Sideband selection may be simpler with phasing and a complete phasing exciter also has built into it provision for the generation of narrow-band phase modulation, should you desire that feature.

Whichever technique is used to generate the single sideband signal at this point, the signal must still be brought to the desired output frequency and boosted to the desired power level.

Frequency selection is normally done by means of one or more mixer circuits, identical in principle to those used in receivers. In fact, the close correspondence between the portions of a SSB transmitter and a superhet receiver is what gave rise to the idea of the SSB transceiver which hit ham radio like a storm several years ago!

Two points, not generally considered of main importance in mixers for receiver use, are important in mixers intended for SSB signal frequency selection. The first is the simple point that an upper-sideband signal is changed to lower-sideband by difference-frequency mixing, while sum-frequency mixing preserves the sideband-to-carrier relationship unchanged. This point, in conjunction with the choice of 9 mhz as the signal-generation frequency in early phasing-type exciters, led to a convention which virtually ruled for a number of years that communication on frequencies above 9 mhz would be by upper sideband, and that on frequencies below 9 mhz would use lower

sideband. The reason was simply that the early users adjusted their exciters to produce USB signals at 9 mhz; sum-frequency mixing to reach the 20-meter band maintained the USB sense, while difference-frequency mixing to reach 75 meters inverted the signals to LSB.

The other point, of considerably more practical importance, is that any mixing process can cause generation of spurious signals. These spurious mixer products can result in out-of-band and out-of-channel signals, and can also introduce in-channel distortion. The point is sufficiently important to cause one authority to state, "It is these spurious products which exert the most influence on the design of the frequency translation system."

To minimize the production of spurious mixer products a designer has two major variables he can juggle. One is the specific type of mixer device and/or circuit he uses, since some circuits and some devices are more free of spurious outputs than are others. More important, in many cases, is the second major variable—the ratio of the two frequencies to be mixed.

For instance, if an output frequency of 7 mhz were desired and the starting frequency were 3.5 mhz, the designer would have only two choices available for his mixing-frequency signal: he could use 3.5 mhz and sum mixing (3.5 + 3.5 = 7), or he could take 10.5 mhz and use difference mixing (10.5 - 3.5 = 7).

In this case, there's really very little choice at all, because one of the first rules is to never introduce two signals of exactly the same frequency for mixing. The output is too likely to contain harmonics of one or both input signals, not to mention literally dozens of spurious products caused by the nth harmonic of one input mixing with the $n+2$nd harmonic of the other.

But the alternate choice wouldn't be very much better, because he would still be faced with all the harmonics of his original 3.5 mhz signal mixing with either the fundamental or harmonics of the 10.5 mhz injection frequency.

It's almost a case of "you can't get there from here"—and this particular problem has been one of the major reasons for choice of

the final stage from ever being seriously overdriven and yet permits the operator to crank up the gain just about as high as he may desire.

Fig. 6 shows how it works. The grid of the final stage is used, in addition to its normal role, as the plate of a diode detector. Whenever overdrive occurs and grid current begins to flow, this diode detector rectifies the overdriving portion of the signal and produces a "hash" voltage at point "A".

This hash voltage is rectified and filtered to remove the "hash", and is then applied to some variable-gain amplifier stage earlier in the amplifier chain. There, it reduces the gain, which in turn reduces the drive to the final stage.

With reduced drive to the final, the hash and in turn the DC ALC voltage are reduced, which permits gain to come back up. Thus we have a closed feedback loop; the greater the drive, the less gain is available, and the less the drive, the greater the gain. The net result is that the final stage will always operate with a very few microamperes of grid current; this is not enough to cause appreciable distortion, but is enough to keep the servo loop operational.

ALC has several advantages. The obvious one is that drive adjustment is not so critical, since it provides an automatic safety against moderate overdriving. Not so obvious is the fact that the operating conditions of the final stage as well as all other stages within the loop are more tightly defined, and so can be designed and adjusted more precisely.

What Faults Mar SSB Signals? In our examination of the means by which SSB signals are generated, we touched in passing on a few of the possible faults. Now let's turn our full attention to the possible problems.

To the operator, most SSB faults appear to be in one of three categories. The first and by far the most populous is that known as "buckshot"; this includes most distortion and non-linearity, and some forms of other problems as well. It gets its name from an audible resemblance to buckshot rattling in a can.

The second broad category is that of "insufficient suppression", either of the carrier or of the undesired sideband. In many cases this problem produces results very similar to buckshot; in others it presents difficulties in receiving the signal.

The final problem is that of frequency stability. We've already seen how stringent are the requirements on frequency stability for SSB communication. Any failure to meet these requirements poses a problem.

Now that we've categorized the faults, let's examine them a bit more closely.

"Buckshot", or to be a bit more precise about it, spurious distortion products, is the normal result of distortion in the power amplifier stages. This distortion may be in the form of harmonic distortion, intermodulation, or both. Such distortion and nonlinearity go hand in hand; one is, in fact, both the cause and the partial effect of the other. A distorting amplifier cannot be linear, nor can a non-linear amplifier fail to produce at least some distortion.

The causes of such distortion were wrapped up succinctly by Don Norgaard W2KUJ, one of the first hams to fo on SSB some 20 years back, as "amplification which increases with increased signal level", and "amplification which decreases with increased signal level". The second of these is the more common; it's what you hear, for instance, if you disable the AVC of a receiver and tune in too strong a signal.

While the causes of distortion fall into these two broad classes (and the cures are different for each class), the results insofar as a SSB signal is concerned are the same for both; in both types of distortion, the result is a *change* in stage gain with signal strength, and as we saw a couple of installments back in this course when we first examined the way a mixer works, any change in stage gain caused by signal strength provides mixing action. In other words, the change itself is a non-linearity.

What happens next is simple; the distorting amplifier puts signals back on, where we have spent so much effort taking them off. If you like, you can try it with figures. Assume that we start with an audio signal containing just two tones, one at 500 hz and the other at 750 hz. Let's generate an upper-sideband signal around a suppressed carrier of 3.9 mhz with these two tones; the result is that we have just two rf signals, one

at 3900.500 khz and the other at 3900.750 khz, if we suppress the carrier and the lower sideband properly.

Now let's put those two rf signals through an amplifier which has a little distortion in it. We'll get out not only the two signals we started with, but their sum and difference; we will also get the sum and difference of each with at least the second harmonic of the other. That is, we can expect to find:

3900.500 - one original input signal
3900.750 - the other original signal
3900.750 - 3900.500 = 0.250 - the difference signal
3900.750 + 3900.500 = 7801.250 - the sum signal
2x3900.500 = 7801 - 3900.750 = 3900.250 - buckshot 2x3900.750 = 7801.500 - 3900.500 = 3901.000 - buckshot

And this is just a partial listing, incomplete at that. In practice, the signal will have more than just two components, and unless we're awfully lucky, we'll have more than mere second-order distortion products to contend with.

We will find that some combinations of frequencies, at some critical orders of harmonics, produce products in the supposedly suppressed sideband. In fact, as it happens it takes a pretty bad signal to produce buckshot within its own bandwidth. A signal which is only moderately lousy will frequently appear to its user, and to its listener, as an acceptable signal; the only people who know it's sick are the fellows trying to use all the rest of the band!

While the major cause of such problems is overdrive, there are other causes as well. Operating conditions for the amplifiers must be properly chosen to minimize distortion, because no amplifier is perfect. Even the best amplifiers have some traces of distortion remaining in them, and good design plays off one factor against another in a hopefully successful effort to cancel out as much of this as possible. The variables to be considered include such things as plate supply voltage, tuned circuit impedances, grid bias, screen voltage, and tube types (some tube types are designed to be more free of distortion than others).

All of these factors are, to some extent, under the control of the operator. At least,

he has enough of them under control to permit him to make any linear amplifier behave. We'll get into the ways and means in our next section when we examine the means of measuring signal quality, because any control must include a means of measurement. Right now, let's turn our attention to the question of suppression.

We have labeled insufficient suppression of either the carrier or the undesired sideband as a fault in a SSB signal, but the reasons why it's a fault are not that obvious.

In fact, in the early days of SSB many operators felt that a reduced-level or "pilot" carrier *should* be transmitted, in order to simplify frequency-locking the bfo at the receiving end. Ancient issues of QST carry some interesting debates on this subject—which would indicate that at the minimum, incomplete carrier suppression is not automatically a "fault" for any technical reasons, but is called a fault only because current operating practice calls for complete suppression!

So far as the undesired sideband is concerned, there are some pretty practical reasons for its suppression. If both sidebands are transmitted and received at full strength, then the locally supplied signal which replaces the carrier in the receiver must be in *phase* synchronization with the original. This is a degree of precision virtually impossible to attain without rather exotic techniques; the only way to do it known to most hams involves more special circuits in the receiver than you normally meet in a phasing-type SSB exciter. It's called "synchronous detection", and we've mentioned it before in this study course.

For any simpler method of reception to work, one of the two sidebands must be shaved away. This can be done either at the transmitter, which gives us SSB, or in the receiver, if DSB is used, but only one of the sidebands may be permitted to reach the detector circuits. If a part of the unwanted sideband gets through, the effect is a "burbling" superimposed on the audio. Experiments have shown that the burble is only barely noticeable when the undesired sideband's level is 30 db below the desired; this is the origin of "30 db" as the "magic figure" for rejection.

The effect of incomplete carrier suppression would depend upon the precision of tuning of the receiver. If tuning were inexact, the local carrier and the incoming carrier would beat with each other to produce a difference frequency which could either cause a low-pitched tone, sub-sonic overload of audio circuits with resulting distortion, or possible an effect similar to the burble of insufficient sideband suppression. If, however, the receiver were especially designed to permit a "pilot" carrier to be selectivity amplified to a much higher level than its accompanying sidebands and then used for local injection, no ill effects at all would occur.

It's a matter of pride among today's operators, though, to obtain as complete suppression of both carrier and unwanted sideband as they can achieve. It's not unusual to find carrier suppression as great as 60 db, and sideband suppression greater than 40 db, in the signal of a really careful operator.

How Is SSB Quality Measured? We've seen that a number of faults can mar an SSB signal, and that the generation of such a signal is a process complex enough to require many adjustments. How can we be sure that all the adjustments are correct, and that our signals are free of the faults which make signals lousy?

Surprisingly enough, an SSB signal is even simpler to measure (in most cases) than is a conventional AM signal, and is much easier to tame than is an FM or PM signal. Measuring its quality, though, does require one instrument—the oscilloscope.

Many operators attempt to measure quality of their SSB signals without a scope, using only a receiver. This fact is one of the major reasons why so many poor SSB signals are found on the air; a large part of the things that can go wrong with an SSB signal are of such characteristics as to show up quickly on a scope view of the signal, yet escape detection completely when the signal is inspected by tuning a receiver across it.

The scope can be used to measure SSB signal quality in any of four different hookups. These hookups are called the two-tone test, the bow-tie test, the envelope test, and linearity tracing. The first three present

essentially the same information, and which you use depends almost completely upon personal preference.

Except for linearity tracing, all the test hookups require that the vertical deflection plates of the scope be driven by the actual SSB signal being tested. The signal is usually picked off from the final amplifier tuned circuits by means of a pickup loop as shown in Fig. 7, and coupled directly to the deflection plates (bypassing the scope's internal vertical amplifiers). Pattern height can be adjusted by changing the location of the pickup loop; the larger the pattern, the easier it is to detect slight flaws.

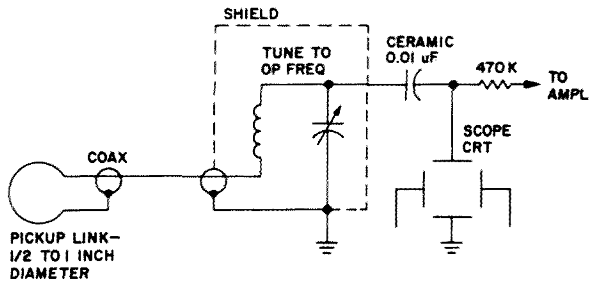

Fig. 7. For two-tone, bow-tie, and envelope tests of SSB signals, this hookup is used to sample rf and apply to vertical deflection plates of oscilloscope. Tuned circuit may not be necessary in all cases, but makes it easier to get adequate pattern size for good display. Pickup link may be coupled to final amplifier, dummy load, antenna tuner, or any point in the transmitter after all adjustments which are to be checked. Pattern size may be varied by adjusting tuning of resonant circuit or by adjusting coupling of pickup link, or both.

These tests depend upon the fact that any distortion or non-linearity will cause mixing and the generation of spurious outputs when two or more signals are applied to the system; that's where the two-tone test gets its name. For the two-tone test, two sinewave audio signals are fed into the mike input of the exciter. The two should be of equal amplitude but about 1000 hz apart in frequency. Alternatively, a single tone can be fed in and carrier inserted to supply the other tone, but if this is done, then only amplifier linearity can be tested. To test for proper carrier and sideband suppression, the input must be a pair of audio tones.

The horizontal plates of the scope, in the two-tone test, are driven by the scope's

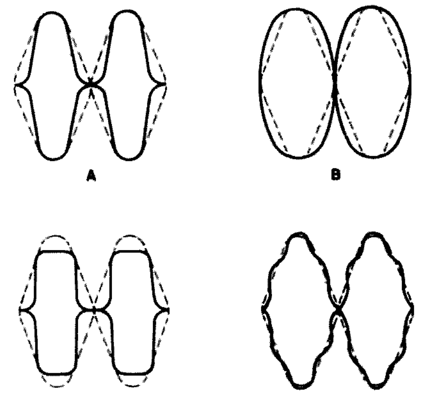

Fig. 8. These are typical displays produced by two-tone tests. Dotted lines indicate normal display in every case. Pattern A results from too much bias on amplifier stage. Pattern B is one of many which can be caused by overdriving a stage; characteristic common of all is that sides of pattern are fatter than normal and top is rounded or squared off rather than coming to smooth peak like a sine wave. Pattern C is combination of A and B, and pattern D indicates inadequate carrier suppression.

internal sweep circuits. It may prove necessary to adjust the sweep carefully, since it normally is synchronized to the vertical-deflection signal inside the scope, and the direct connection used in this test set-up bypasses that part of the circuit.

The pattern which should be displayed by a perfectly operating transmitter on a two-tone test resembles a pair of sine waves mirror-imaged over each other; it appears as the dotted line in **Fig. 8.** Any of the patterns shown by solid lines in **Fig. 8** represent improper operation. Pattern A is an exaggerated view of what is shown when an amplifier is overbiassed; the "crossover" is pinched and the sides of the pattern become concave. Pattern B is an indication of overdrive; the pattern "fattens out" and in extreme cases may even begin to look like a square wave. Pattern C indicates a combination of too much bias (Pattern A) and too much drive (Pattern B).

Pattern D indicates insufficient carrier suppression; the more carrier is present, the more pronounced will be the ripple along the edges of the pattern.

The envelope test is identical to the two-test insofar as the scope hookup is concerned, but the audio input for this test is normal speech. Horizontal sweep for the scope is furnished by the internal scope circuits, set for approximately 30 sweeps per second. The envelope test, in itself, tells very little, but is useful as a means of monitoring the signal once all adjustments have been set up properly using either the two-tone or the bow-tie tests, to be certain that overdriving is not permitted to occur.

The bow-tie test differs from the two-tone test in two major respects; the horizontal sweep for the scope is taken from the exciter's audio section, and the pattern produced is somewhat different.

In this test, the scope is used to compare the *audio* signal generating the SSB output with the actual *SSB* signal produced at the system output. If everything is working properly, the relationship between these two signals will be linear. The result is the stylized bow-tie pattern on the scope shown at A in **Fig. 9.** The perfect straightness of the sides of the pattern, extending through the crossover at the center, indicates that all operation is normal and signal quality is good.

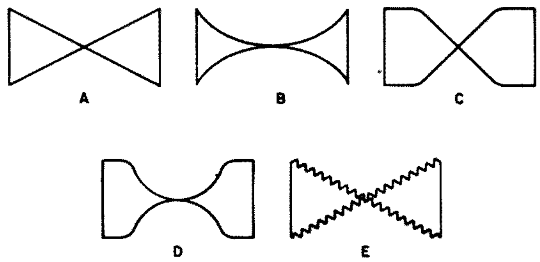

Fig. 9. Typical bow-tie test patterns. Pattern A is normal indication; all lines are perfectly straight. Too much bias produces concave-sided pattern such as B. Overload produces pattern C, with chopped-off peaks rather than points. Combination of overdrive and too much bias produces Pattern D. Inadequate carrier suppression puts ripples on sides of pattern as at E.

Too much bias (which produced Pattern A, **Fig. 8,** with the two-tone test) will cause the sloping sides of the bow-tie to become concave as shown at B, **Fig. 9.**

Overdrive, which causes the peaks of the output signal to be clipped, shows up as Pattern C. The combination of too much bias and too much drive, which produced Pattern C in **Fig. 8,** appears as shown at D in **Fig. 9.**

Lack of carrier suppression will show up as at E, with ripples on the edges of the

pattern, and as in the two-tone test, the depth of the ripples indicates the amount of carrier.

Either the two-tone or the bow-tie test can be used to adjust amplifier loading. An amplifier which is too lightly loaded will display the pattern of "overdriven" conditions, but the pattern will clear up into the "normal" pattern as loading is increased. As loading is increased still more, the pattern will remain "normal" but its height will decrease, indicating that less actual power is being produced (regardless of what the final meters may indicate—all that they show is dc input power, and the display is showing you actual rf output voltage across a fixed load impedance).

The point of optimum loading, for any given amount of drive, is that point at which the largest "normal" pattern is produced. Once this point is found for a single drive level, it's usually worth while to increase the drive a bit and see if a better "optimum" can be found. This boils down to a pair of rules: If the final stage is not being driven to its design limit, its loading should be reduced until it will accept limiting drive, and if the power level obtained by doing this is less than anticipated, provide additional drive.

While we've been going into some detail on three of the four test setups, we have passed by the technique known as "linearity tracing". Unlike the other three setups, linearity tracing does not involve feeding rf to the scope. Instead, samples of the rf input to, and output from, the amplifier being tested are detected by identical linear detectors. The resulting signals are then compared to each other in the scope, by applying one ot the vertical amplifier and the other to the horizontal.

Fig. 10 shows the schematic of a typical

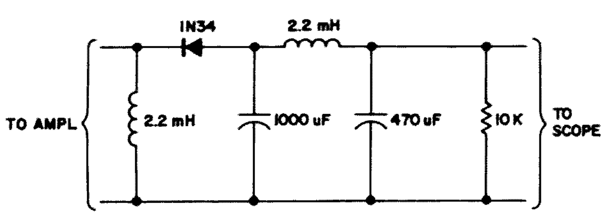

Fig. 10. Schematic diagram of linear envelope detector for linearity tracer. Entire circuit should be shielded, with coax leads running in and out.

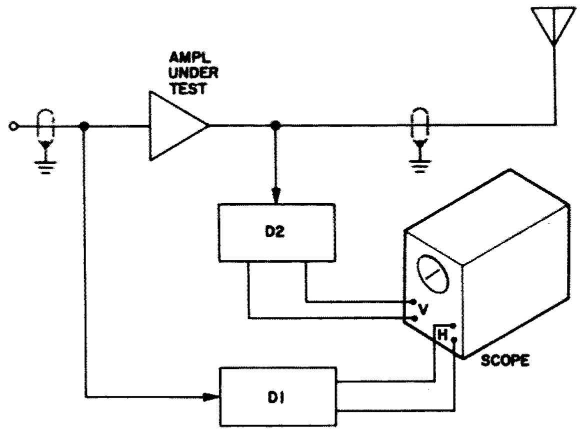

Fig. 11. Test setup for linearity tracing. Detector coupled to amplifier input should feed horizontal input of scope, and second detector coupled to amplifier output should feed vertical input. Scope gain adjustments should be set for 45° tilt on displayed line or curve. This requires more horizontal gain than vertical.

linear detector for such use, and **Fig. 11** shows the test setup in block diagram form.

Any type of audio input can be used for this test, since it merely compares the output of the amplifier to the input. If the amplifier is linear, the display will be a straight line as shown at A in **Fig. 12.** A curved line such as that at B indicates too much bias or insufficient screen voltage; the specific problem indicated by this is "crossover distortion" caused by too little static plate current. An oppositely curved line such as that at C indicates poor grid-circuit regulation or plate-circuit difficulties, with improper loading as one of the prime suspects. The "S" curve at D is simply a combination of curves B and C, and indicates that several problems are present simultaneously. Overdrive of the amplifier is shown by a sharp break in the line as at E.

The linearity tracer, because of the simplicity of interpreting its display, is probably the best measurement technique for everyday measurement of signal quality. The bow-tie test provides similar results. Most commonly used is the envelope test—which is the least indicative of all.

How Does The Receiver Affect SSB? Having generated our SSB signal and measured its freedom from faults, we can pour it forth into the spectrum without shame. To use it for communication, though, we still must receive it.

We have examined some of the details of SSB reception elsewhere in this study course; what we'll concentrate on right now are three important ways in which receiver features affect the usefulness and intelligibility of the SSB signal.

Since the SSB signal has no carrier to permit recovery of the audio, the receiver must provide a substitute for the carrier. This "local carrier" is normally provided by the bfo, and it must meet two requirements—it must be strong enough so that the received sideband cannot "overmodulate" it, and it must be at proper frequency to demodulate the sideband into its proper audio components.

The problem of strength of the bfo signal can always be overcome by attenuating the received sideband, and this is the idea behind the way in which SSB is received on a pre-SSB receiver: Audio gain is turned full on, rf gain way down, and the receiver tuned carefully until the SSB signal becomes intelligible. Keeping the rf gain down low makes certain that the sideband is at low level when it mixed with the bfo signal in the detector circuits; the audio is kept high to make the best of a bad situation.

Tuning of the bfo is comparatively critical; it must be on the right side of the sideband to replace the suppressed carrier, and must be within a very few cycles of the

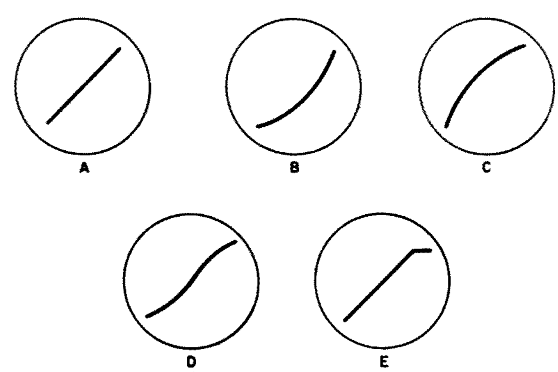

Fig. 12. Typical displays from linearity tracer tests. Perfectly straight line such as that at A indicates perfectly linear operation of amplifier. Concave curve such as B results from overbias of amplifier or too little resting plate current. Convex curve, C, results from improper loading or poor grid-circuit voltage regulation causing drive to change with signal level. S-curve, D, is combination of faults B and C. Overdrive of amplifier is indicated by sharp break at top of line, E. It may also be combined with any of the other patterns.

suppressed carrier's frequency to reproduce the audio accurately enough to permit voice recognition.

If DSB signals are to be received, the receiver must have sufficient selectivity to slice off one sideband and accept the other, or the signals cannot be comfortably received. This selectivity may be achieved by a sharp filter in the *if* strip, or by a phasing technique similar in principle to the phasing type of SSB generator. Such a phasing device is often called a ' signal slicer"; in the early days they were popular accessories, but the sharp-filter technique appears to be predominant now.

Frequency stability is also a necessity in the receiver, both in the front end and the bfo oscillator circuits. Because of the need for extreme absolute stability (tuning should stay put within 50 hz, regardless of operating frequency), multiple conversion techniques have become almost standard for SSB receivers. These employ crystal-controlled converters to bring all incoming signals into the same frequency range, where a single variable oscillator which is built for extreme stability is used for tuning. Often, the bfo is crystal-controlled, with choice of upper or lower sideband being made by switching to one of two crystals, either above or below the *if* passband by the correct amount.

. . . Staff

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"Fundamentals of Single Side Band," Collins Radio Company, publication 597 0331 00, 1959 (may be difficult to obtain but contains extensive discussion of SSB principles, linear amplifier design, and mixer considerations; aimed principally at commercial users).

"Single Sideband for the Radio Amateur," Publication No. 20 of "The Radio Amateur's Library," ARRL, Newington, Conn. (Second and third editions, in particular, contain material of historical interest relative to early amateur practice.)

"Single Sideband Techniques," Jack N. Brown W3SHY (edited by Oliver P. Ferrell), Cowan Publishing Corp., 1954 (now out of print but of historical interest as one of first books published on amateur SSB).

(continued from page 4)
or hobby. In other words; make the public believe that our activity is a vitally important part of civilized societal welfare, contributing essentially to the common good. It was intimated that those nations would then be unable to commandeer our frequencies, and that we would be secure from those who persisted in casting covetous eyes in our direction. Hogwash!!!!! The bare truth is; if every ham in the USA were to achieve the technical competence of an electronic wizard, the prowess of a genius, those nations would still seek expansion of their frequency allotments at our expense. If we handled traffic from now till Doomsday . . . if we all became active in AREC, RACES and MARS . . . if we eschewed the hobby aspects completely . . . if we designed and built our own stations to the total exclusion of commercially built gear . . . these nations would still be attempting to acquire our precious bands. They only know that they have a propaganda story to tell the rest of the world. So far as ham radio is concerned, they couldn't care less!

The tragic thing is that ARRL could not possibly have failed to know all about this at the very time we were being regaled with this pleasant little fairy-tale version of the real facts. Why were we not told the real reasons for the League's championing of Incentive Licensing? Many have speculated about this. One account holds that the League found it necessary to create a fake issue around which to rally some controversy, in order to inspire vitality where merely bored indifference and ennui existed. That they succeeded in provoking the exact opposite was patently obvious in short order.

Even when it became painfully clear through the correspondence to the League, to QST, and to individual Directors, that those in favor of the proposal were but a negligible minority, consisting predominantly of engineers, older members who had been around long enough to "grandfather" into the Extra Class, and a number of gullible, impressionable persons who believe anything they see in print, still the League held fast to its committed course, like a juggernaut plunging downhill. Like certain politicians of recent vintage, they found it unbearable to own up to having made a mistake. They refused to retreat, simply because it was regarded unseemly for ARRL to show any sign of human fallibility. Talk about a credibility gap! Talk about false pride! Oh, brother!

The letters of objection, in the main, were characterized by the loyalists in precisely the way you might expect. They accused the writers of being unprogressive, indolent, short-sighted, stagnant, or downright seditious. You doubtless know that there have been instances when any adverse criticism of the League, no matter how mild, has been interpreted as high treason, as though the critic were a bomb-carrying anarchist. . . . . or at the very least, certainly no gentleman. "Foul," cry the Old Guard. ("Off with her head," cried the Queen.)

Now the bands are decimated. An FCC evaluation of the sub-bands is certain to disclose that which we already know . . . there's hardly anyone using them. They are sterile monuments to cocksureness and obstinacy. Why? Because, despite the percentages quoted, comparatively few amateurs have taken the trouble to upgrade. Those who have, were not impelled by any desire merely to demonstrate their technical ability for its own sake. They were motivated rather by their operating needs; they wanted to hang on to DX frequencies, for example. Nobody felt particularly noble about it, like winning a Phi Beta Kappa key, or the Congressional Medal. If a golfer wants to swat a three hundred yard tee shot instead of his customary two hundred, he goes out and buys a special high compression ball for three bucks, and gets a driver with a longer shaft and weighted clubhead. If a ham wants to work the restricted sub-bands, he studies some theory, brushes up on his CW, and goes down and takes the exam. The guy doesn't do it in order to fulfill his birthright as a red-blooded patriot, nor in order to uphold the honored traditions of our pioneers, nor yet in an effort to protect our "sacred" frequencies from the depredations of unfriendly foreign powers. He does it for the same reason he pours high octane fuel into his gas tank; in order to gain an advantage. By improving his performance he increases his own enjoyment. This is the way of the world . . . we do what we do for personal reasons . . . it's the nature of the beast! And though poets and philosophers may rhapsodize about the inherent nobility of man's spirit, the sad truth is that man's fundamental and predominant instincts are based upon self-interest. We are not a race of idealists, nor altruists, we humans. Ask any clergyman or psychiatrist. They deal with human frailty every day, and they know.

I'm no misanthrope, really. I truly love my fellow man. I'm just getting a bit fed up with those who constantly judge others and exhort them to be exemplars of saintly behavior, while pridefully refusing to heed the ancient dictum; "Physician, heal thyself." A great philosophical figure once said, "Love the people for what they are; not for what you would like them to be." I think there are far too many who try to remake others into more acceptable molds. What a travesty for mere man to regard himself so high and mighty that he can judge someone else! Of all human sins, I think sanctimonious pride is the worst. Self appointed hypocrites are all over the place, criticizing the government, college administrators, parents, clergy, the military, the rich, the poor, the old, the young . . . you name it. I'm not qualified to preach the Gospel, but I wish fervently that more people would read the 7th Chapter of St. Matthew, with special emphasis on the first five Verses.

Well, anyway, to get back to the subject; despite those few endorsements of the League's position, hardly anybody was actually in favor of it. There was never a mandate from the membership, signifying wide-spread enthusiasm. Quite the reverse! And the wholesale resignations which

coincided with the adoption of this scandously unpopular change, are not attributable to other factors. The deepening diminution of our numbers may not be laid at the doorstep of the USSR, the fuzzy-headed liberals, the unwashed, the bearded, college youth, black militants, 73 Magazine, or any other of dozens of favorite scapegoats. The ARRL, and only the ARRL is responsible.

It must be stressed that not all the Directors were in accord with the change. Some received mail, which must have been most distressing. But there is incredible pressure on these men. Perhaps many of them would deny this, but such a denial would only tend to confirm the existence of pressure.

To repeat; if the second phase goes through as scheduled, there will most likely be an unprecedented exodus from our ranks. But, at least, we now know from QST that there are second thoughts about it all. Some chickens have assuredly come home to roost. Unless I am very much mistaken, our Directors are now more aware of the thinking of their constituents than they were before. I am glad we have been asked to write to our Directors. I hope that the response will dwarf all expectations. I hope there will be a deluge of mail . . . a protest so loud and insistent that it cannot be overlooked or swept under the rug.

I wish ARRL well. It is my organization, just as it is that of the functionaries who run it. I, too, am concerned about it. I, too, am dedicated to its welfare and growth. I, too, want to contribute all I can toward making it better and stronger. That is why I believe so fervently that our best hope lies in the direction of far less centralism, and far more democracy.

By all means, let's preserve our precious traditions and heritage. Let's not ever fail to continue to honor our esteemed founders and pioneers. Let's keep our memorable past evergreen and fresh in our minds. But, let's not forget that our League exists to function in the best interests of all of Amateur Radio . . . not just a group here, and a group there, no matter how we respect them nor no matter how prestigious they are.

I'm just waiting for the day when a man who is not in complete favor with the leading circles in Newington is elected to be Director of his division. After all, we can afford to have a two party system in our Federal Government; why must there be complete unanimity of viewpoint in the American ham population's organization? I'm just waiting for the day when the League stops resting on its laurels; the great achievements of those who lived in a far less complicated time . . . a time when it was much less difficult to cope with adversity. I do not seek to denigrate these men. They were brilliant and resourceful, and beyond a doubt they were surely dedicated to the cause of ham radio. But the present circumstances are not going to be dealt with by looking over our shoulder. Prayerfully, if ever the ARRL commences to realize that yesterday's answers will not suffice for today's questions, then there might be a gleam of hope for tomorrow.

There is a group of people who think that because I have criticized the League from time to time, I have severed my connection with it. I have been a member and active supporter of ARRL for practically all the time I have held a ticket, and have seen no reason to change my posture with respect to this. That is...until recently. Lately, I have been wondering about it all.

The constant message of ARRL has been that it is a democratically run organization, beholden to its members through their duly elected representatives, and accountable to the rank and file through the instrument of the election process. But, just how democratic is an organization in which the sole participation of the membership is merely the casting of a single ballot once every couple of years? And are these representatives truly answerable to the membership? Or are they answerable to those in control of the machinery of the League?

Is it possible to effect changes in ARRL through its Directors? All of us have mixed feelings about the League's programs and activities. Some of us disagree on incentive licensing. Some find fault with the failure of ARRL to implement reforms in the iron-handed approach to DX accredition. Still others feel badly about the Legal Department's reticence to become involved, except in an advisory sense, in lawsuits where fundamental rights of amateurs are imperiled. And so forth. While all these disagreements are going on, we are told...-"You can only improve the League from the inside." This is the word from Headquarters, echoed by the Directors, SCM's, EC's, and on and on, down the line. The message is, join....join.... join....no matter how strongly you may disagree with the direction and policies of leadership.

Isn't it time to mull over this state of affairs, in order to determine the wisdom.... or folly...of following blindly? Have there been any meaningful changes, suggested by the rank and file, not the officials, carried out by these "responsive" representatives?

Many have pleaded for the necessity of a new look in policy, with respect to our total lack of an affirmative public image. I challenge you to name one other national organization that does so little for its members. We desperately need a voice in Washington. But the League is so all-fired concerned with maintaining their tax-free status, that it is neglecting the fact that so far as the public is concerned, we are nothing but a bunch of idiots, who deliberately interfere with television; a group of arrested old crackpots, playing with toys and childish gimmicks. Literally a handful of people are aware of the role of Amateur Radio in our society. Hardly anyone knows that there is a difference between hams and CB'ers. All right...agreed that if we established a voice in the Nation's Capital, we would no longer be tax-free. So what! Other groups are paying their way without too much strain. What does it profit us to be tax-free, if we suffer million dollar damage suits when some crackpot sees a ghost on his TV screen? If we enjoyed good public relations, no attorney in his right mind would dare to institute such action to begin with. Supposing it does cost us some money? Heaven knows, we have it. And why should we operate by government handout? Many hams who make no bones about their opposition to huge government deficit spending...relief...Social Security...foreign aid, don't even think twice about the fortune it costs out Nation every year in the form of uncollectable taxes from outfits like ARRL. Any other similarly successful publishing firm would be carrying its own weight; paying its own freight; not freeloading on a technicality.

And it is just that. If you take an educated squint at the ARRL annual report you will discover that about 10% of our money is spent in behalf of hams. DXCC, Communications Department, W1AW, Clubs, etc., are all run as inexpensive window dressing in order to maintain the tax-free status. The remainder, a whopping 90%, less salaries and expenses, is reserved for the publishing activities. This is a million-and-a-half dollar publishing firm we're talking about. What happens with all that money? I think we have a right not only to know, but to determine how and where it is spent, or invested, or what have you.

The point is, if the League really started working for its members, instead of just for its bank account, it would probably have no trouble doubling the membership dues, for the members would feel they were getting something for their money. In terms of new members, forget it...we could increase our membership by leaps and bounds.

It is not enough to publish QST and blow our own horn. No one but hams read it! We are in dire need of national coverage on the wire services, press and periodicals, radio and TV. We need promotional ideas; not just a single little film to show at ham clubs, either. And we can certainly do without the tired old blurb that appears every so often in the magazine, about getting the local news editor to give us a couple of lines, or arranging for a spot on the Wednesday luncheon program of Lions, Kiwanis or Rotary. For a sample of this impotent pap, just take a gander at QST for May, 1969. Then compare it with QST for May, 1967. They're the same, word for word, except for changes to accommodate the calendar. You see, public relations is so unimportant, the editorialist doesn't even take the time to write a fresh piece about it! After all, it might take as much as an hour of his valuable time. So, he conveniently exhumes the old one. Nobody read the darned thing anyway, so why bother with a new one!

We hear moans and groans about our dwindling numbers, and many proposals that we ought to seek the means of remedying the situation. But thumbs down on the one thing that would really accomplish the task; a public relations office in the City of Washington, D.C. Outside of a few dozen dedicated individual hams, nobody's doing anything about recruitment. There's not much in the way of a program for junior and senior high schools, other than the radio clubs in these institutions, themselves, and the handful of teachers there who happen to be amateur operators. Of

course, in all honesty, the League does print some material on this project, but how many people send for it and use it? Not many!

We spend a lot of valuable time and effort in the glorification of the past... Wouff Hong, 50th anniversary, museums, T.O.M., etc., but we do not devote much of our energy to the proselytization of our young citizens. I'll guarantee you that at least a few young acid heads might not be in their present loathsome predicament if some hams had attracted their attention to Amateur Radio in time to make an impression. And perhaps there are some guys sitting around in pool-halls, letting their minds stagnate, who might have been involved meaningfully in our hobby, if only someone had taken the trouble to stimulate and nurture their interest. Think about it!

Now; can anything be changed from inside the League? Perhaps it can. But not unless a struggle takes place. Up to now, most such efforts have met with failure. Those candidates who have proposed the most sweeping changes, which might have changed the League for the better, have never succeeded in being elected. I do not accuse anyone of rigging elections. But there are many similar organizations which have found it advantageous to permit their elections to be supervised by outside, impartial personnel. In this way, at least, there can not be any question of skulduggery, and this is one positive advantage. Many unions and guilds run their elections under the aegis of the Honest Ballot Association, which has a long history in this field. Since we are assured that our elections are scrupulously honest, we have nothing to lose by permitting such outside supervision. That is, we have nothing to lose, unless the elections are being rigged. The writer is a member of ASCAP, the performing rights society of the publishers and songwriters. The Government made us sign a consent decree, permitting them to oversee our activities. This was not done because of any dishonesty. It merely made it easier for persons in sensitive positions to avoid temptation. ASCAP collects and distributes over $40,000,000 per year to its members, and all of us are happy and secure in the knowledge that not one penny is sticking to anyone's fingers. But we were sure of this before the consent decree. The decree has merely made it possible for us to be doubly confident that our organization is being administered with integrity. I find absolutely nothing objectionable in putting an extra lock on my front door, or installing a burglar alarm in my automobile! Why then, should anyone object to reasonable precautions being taken, so as to guarantee the integrity of the elections in the American Radio Relay League?

Another thing; the only time your membership really counts for anything at all is when you write your check. Take the large business firms....take Detroit, for instance. Tens of thousands of car buyers told the manufacturers they wanted economical compacts. They were ignored. So, they began buying VW's, Volvos and Renaults. The moment the dough started to diminish, and not before, Detroit started to make economy cars. People bought them by the thousands. Detroit then raised the prices, typically. The public went back to Volkswagons! Finally the light dawned on Detroit! But their short-sighted stupidity cost them billions of dollars. And that is why you see so many VW's and Toyotas today.

Well, what can be done? I suppose the staunch and dependable old guard will begin calling me an ingrate, a renegade, a blackguard, or worse. There has already been a snide reference to Wayne Green in the August editorial of QST, on the basis that he was not exactly bowled over by a new film which was screened recently. You have been warned that you will see adverse criticism of the film in this magazine. So far as I know, the film is a nice, innocuous, little thing, neither good nor bad, but certainly nothing new or startling. And it is not going to be premiered at the Radio City Music Hall or Graumann's Chinese! It will be shown at ham clubs, and if that is the League's idea of public relations or publicity, I regard it a total waste of time. So, I'm anticipating outraged yells of "foul" from Headquarters. Remember, though, what General Motors tried to do to Ralph Nadar when he got into their hair? They tried to frame a phoney moral turpitude charge against him. They had to admit it in open court when he fought back, confronting them with irrefutable evidence. They had to eat crow...but good, when they were exposed for the filthy conspiracy they tried to engineer. I trust that no one in Newington comes up with any such bright idea. For the Nader vs. General Motors case establishes the illegality of this type of reckless adventurism.

Until the League demonstrates a willingness to act in accordance with the expressed will and interest of a large segment of the amateur fraternity, including vast numbers of its own membership, rather than the special interest of the Headquarters group alone, I am very much afraid that it cannot count on the strong rank and file support it persistently claims to enjoy. This is a time when we all need to recognize that democracy is one thing....oligarchy is quite another. The type of paternalism which we get constantly in QST insults the intelligence of every rank and file member. We have recently seen an example of arrogant contempt which sank to a hitherto unplumbed depth. If there were any doubt at all, it was surely dispelled by the disgraceful editorial of last February! We were not even credited with the ability to determine the content and substance of our conversation; that's how much faith they have in our intellectual capacity.

We are no different than any other fraternal or political entity. Either we have a voice (I mean a real voice) in our organization's policies, or we haven't. If the latter be true, then it is high time for some sweeping changes. And these can be accomplished in only one positive way. Remember Detroit!

Dave Mann K2AGZ

Technical Aid Group

Please refer any questions of a technical nature to one of the following members of 73's Technical Aid Group. These are dedicated amateurs who really want to be of help and do so without compensation. Be sure to state your problem clearly and enclose a S.A.S.E. for a reply.

John Allen K1FWF, high school student, 51 Pine Plain Road, Wellesley, MA 02181. HF and vhf antennas, vhf transmitters and converters, AM, SSB, product data, and surplus.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, NY 11360. Novice help.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, VA 22042 General.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, IL 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Glen H. Chapin W6GBL, 3701 Trieste Drive, Carlsbad, CA 92008. HF and vhf antennas, novice transmitters and receivers, vhf converters, semiconductors, receivers AM, SSB, general, surplus.

Ted Cohen W4UMF, BS, MS, PhD. 6631 Wakefield Drive, Apt. 708, Alexandria, VA 22307. Amateur TV, both conventional and slow scan.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans LA 70118. Novice help and general questions.

George T. Daughters WB6AIG, BS, MS, 1560 Klamath Drive, Sunnyvale, CA 94807. Semiconductors, vhf converters, test equipment, general.

Gary De Palma WA2GCV/9, P.O. Box 1205, Evanston, IL 60204. Help with AM, Novice transmitters and receivers, vhf converters, semiconductors, test equipment, digital techniques and all general ham questions.

Steve Diamond WB6UOV, college student, P.O. Box 1684, Oakland, CA 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, vhf antennas and converters, receivers, semiconductors, and product data.

Frank M. Dick WA9JWL, 921 Isabelle Dr., Anderson, IN 46013. Will answer queries on RTTY, hf antennas, vhf antennas, vhf converters, semiconductors, mobile, general, and microwave.

David D. Felt WB6ALF, 79 East Highland Ave., Sierra Madre, CA 91024. Semiconductors, IC's, television, test equipment, product data.

Louis E. Frenzel, Jr., BAS, 11287 Columbia Pike, Silver Spring, MD 20901. Electronic keyers, digital electronics, IC's commercial equipment and modifications, novice problems, filters and selectivity, audio.

Paul Gorrell, high school student, P.O. Box 228, Mashpee, MA 02649. Novice transmitters and receivers, hf equipments, CB to ham gear conversion. Marine to ham gear conversion, Civil Air Patrol Communications, all aspects.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, CA 95240. TV, hf antennas, SSB, vhf antennas and converters receivers, semiconductors, and general questions.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, NY 14619. Specializes in vhf/uhf solid-state power amplifiers, but will be glad to make comments on any subject.

D. E. Hausman VE3BUE, 54 Walter Street, Kitchener, Ontario, Canada. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO NY 09665. Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 SW Salmon St., Portland, OR 97205. This group of radio amateurs will answer any technical questions in the field of electronics.

Douglas Jensen W5OG/K4DAD, BA, BS, 2505 Broadway, #1704, Houston, TX 77012. Digital techniques, digital and linear IC's and their applications.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, WI 53402. Novice transmitters and receivers, general.

Ira Kavaler WA2ZIR, BSEE, 671 East 78 Street, Brooklyn, NY 11236. SSB transmitting, color TV, computer programming and systems, digital radio and remote control, rf transmission lines, dipole design, audio amplifiers, linear and class C rf amplifiers.

Ronald King K8OEY, Box 227, APO NY09240. AM, SSB, novice transmitters and receivers, hf receivers, RTTY, TV, test equipment, general.

G. H. Krauss WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, NY 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitters and receivers, vhf antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Bert Littlehale WA1FXS, 47 Cranston Drive, Groton, CT 06340. Novice transceivers, test equipment and homebrew projects gone wrong.

J. J. Marold WB2TZK, 279 Farmers Ave., Lindenhurst, NY 11757. General.

Wayne Malone W4SRR, BSEE, 8624 Sylvan Drive, Melbourne, FL 32901. General.

Charles Marvin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, OH 44084. Will help with any general amateur problems.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, CA 94952. Double sideband.

Fred Moore W3WZU, broadcast engineer, 4357 Buckfield Terrace, Trevose, PA 19047. Novice transmitters and receivers, hf and vhf antennas, vhf converters, receivers AM, SSB, semiconductors, mobile test equipment, general, product data, pulse techniques, radio astronomy, bio-medical electronics.

Eduardo Noguera M. HK1NL, EE. RE, P.O. Box Aereo 774, Barranquilla, Columbia, **South America**, antennas, transmission lines, past experience in tropical radio communications and maintenance, hf antennas, AM, transmitters and receivers, vhf antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, **CA** 91780. ATV, vhf converters, semiconductors, general questions.

John Perhay WAØDGW/WAØRVE, RR #4 Owatonna, MN 55060. AM, SSB, novice transmitters and receivers, hf receivers, vhf converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, PA 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

Howard Pyle W7OE, 3434 7th Avenue, S.E., Mercer Island, WA 98040. Novice help.

Robert Scott, 3147 East Road, Grand Junction, **CO** 81501. Basic electronics, measurements.

Pfc Grady Sexton Jr. RA11461755, WA1GTT/DL4, Hedmstedt Spt. Detachment, APO **NY** 09742. Help with current military gear, information from government Technical Manuals.

Walter Simciak W4HXP, BSEE, 1307 Baltimore Drive, Orlando, **FL** 32810. AM, SSB, Novice transmitters and receivers, vhf converters, receivers, semiconductors, mobile, test-equipment, general.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, **NY** 11357. General.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, **IL** 61820. Antennas, transistors, general.

Jon Teich WB2JAE, 22 Olden Road, Ediron, NJ 08817. General assistance and problems with rigs.

James Venable K4YZE, MS, LLB, LLM, 119 Yancey Drive, Marietta, **GA** AM, SSB, novice gear, vhf, semiconductors, and test equipment.

Hugh Wells W6WTU, BA, MA, 1411 18th Street, Manhattan Beach, **CA** 90266. AM-FM receivers, mobile test equipment, surplus, amateur repeaters, general.

William G. Welsh W6DDB, 2814 Empire Ave., Burbank, **CA** 91504. Club licensing classes and Novice problems.

Michael Winter DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, **OH** 45342. HF antennas, AM, SSB, novice gear, semiconductors.

Modifying A Kitchen Clock for the Shack

In this shack a kitchen type clock is used for logging. And, being just a bit fussy about the time, I made two small but useful modifications. I'm not so sure that it's all that important or necessary to be that accurate, but we all have our small idiosyncrasies of one sort or another.

In this case, I took the old clock from the kitchen after convincing the wife that she should buy a new one. The second step, or maybe it should have been the first, was to determine that the hands of the clock did not have any flop to them. Flopping hands would not make a very accurate clock. You may have to "set-a-while" and watch the clock, but you can do this while you talk to some interesting station.

The first step was to add an extra hand to the clock so whenever I had to convert from local EST time to GMT time (for the local MARS net), I was able to do this with just a glance at the clock.

Next, I took the clock apart and cleaned it in a good detergent (except for the motor), to get off the years of grease. The small hand was removed from the clock, the paint removed, and the third (GMT) hand, fabricated from sheet metal, was soldered onto the small hand. Both were repainted (different colors), and put back on the clock. *Be sure to get the proper angle to the third hand before you solder it!* Before you put the clock together, put a small switch in the bottom of the clock and wire it to open the line to the clock.

Reassemble the clock and plug it in to see if it still works. If so, fine! You are now ready to set the clock to the proper time. Get a convenient time signal: WWV; Bell Telephone; or my particular favorite is the Canadian time signal from CHU. They give the time announcements every minute and give you 1 pulse every second, with a blank pulse at the 30 second period. I look for CHU on 3330 kHz and 7335 kHz and find them quite well on both. Stop the clock with the second hand on the 12 and the other hands of the clock set to what ever the approximate time happens to be, *plus* one minute. When the proper time is announced which corresponds to your clock setting, switch it on. Unless your line frequency changes, you should hold the time quite well for a long time.

The need for the switch was necessitated by the fact that my clock is accessable, but the plug is quite out of the way and out of reach. If your wall plug is handy, you can omit the switch.

I have found that this small extra hand and switch adds just one more small convenience to the operation of my ham shack.

R. Bailey, K3AQH

SBE Improvements Made Easy

R.E. Barrington W6JDD
1087 Hewitt Drive
San Carlos, CA

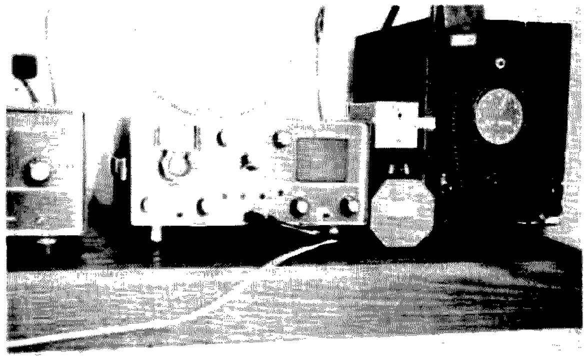
If you are the owner of an SB-34 transceiver or the exciter-SB2 linear combination, have you ever wished:

1. The stuff didn't get so hot!
2. The exciter stayed on slow-speed vernier tuning all the time?
3. You had an "S" meter.
4. You could use any one of several mikes . . . and still completely modulate the rig?
5. The gear didn't thump from the receiver's speaker when switched from receive to transmit and back again?

Let me hasten to say that the foregoing is not meant as a slur against SBE equipment. Certainly the SB-34 is a pretty advanced design as transceivers go. And by the hundreds they're bringing a lot of pleasure and operating satisfaction to many sidebanders today.

Let's consider one point at a time. First, heat. Both the SB-34 and the SB2-LA *do* generate a tremendous amount of heat. Unfortunately, the cause results from the features that make these rigs so desirable—extremely compact size, but with built-in power supplies, both ac and dc, in the case of the transceiver.

There is no room at all for any kind of a satisfactory fan for mounting inside of a 34; virtually impossible in the linear, too. But both pieces of gear do have grillwork openings, top and bottom. Therein lies a simple and most effective solution to the problem, with a modification to the operating work space (instead of the equipment), and the addition of a pair of Muffin or Whisper fans.



Modifying the work space rather than the equipment may even improve the appearance of the shack.

If your operating table or desk is a bit fancy to cut holes in directly, a section of elevated plywood as a false top will serve nicely. Use whatever's handiest, then cover with wood grain contact paper. The result will probably look better than your operating surface did in the first place!

This arrangement makes a dramatic difference in the operating temperature of both the transceiver and the linear. Never again will any of the crystals or transistors quit... at least not from heat.

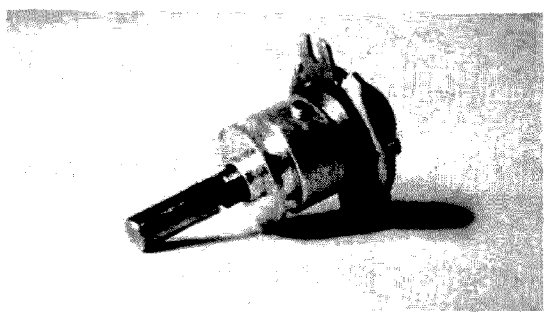
The two-speed vernier dial drive on the SB-34 has been a source of annoyance to many owners. If you prefer a slow tuning rate, don't hesitate to remove this unit.

The dial drive shaft is segmented into two sections. Actually, where the slot appears between the two shaft sections, the soft brass of the factory units has an eccentric notch. The opposing steps or notches are placed in such a way that the outboard shaft turns several degrees of a circle before engaging the opposite notch. It is this engagement that forces the clutch arrangement of the mechanism into a fast speed mode.

A quick cut with a hacksaw blade removes the notch on one shaft or the other. Presto! No eccentric engagement. . .smooth, constant slow speed tuning!

The SBE people will tell you that the 34 is on the shy side for audio gain. Many owners have had to give up using their favorite mike because it simply wouldn't drive the rig. A highly satisfactory solution to this problem is transistorized pre-amplification—or better yet, compression. For the owner who really wants improvement in audio punch and mike flexibility at very low cost, the best solution I've seen yet is a $4.95 modification to the 34 available nationally through the Radio Shack stores. The simple outboard modification is designed around an Archer solid state module, known as the CB Compression Amplifier.

The Archer unit is encapsulated in plastic with screw terminals for 3 volts of battery and audio in and out. Knob twisters can't louse it up! A fixed threshold of compression is built in with no adjustments.



The vernier tuning drive shaft for the SB-34.

With the suggested compressor in the circuit between your mike and the exciter, you'll get much higher average output than ever before (without flat-topping) at a mike gain setting backed off as far as 8 o'clock.

The diagram (**Fig. 1**) illustrates some simple precautions to be taken in assembling the SB-34 adaptation. With the switch in the battery-off position your mike feeds straight through, so you can quickly test in and out of the circuit. If you use a linear, the rf chokes are a must to avoid feedback at the higher frequencies. It's also a good idea to ground the minibox to your transceiver chassis electrical ground.

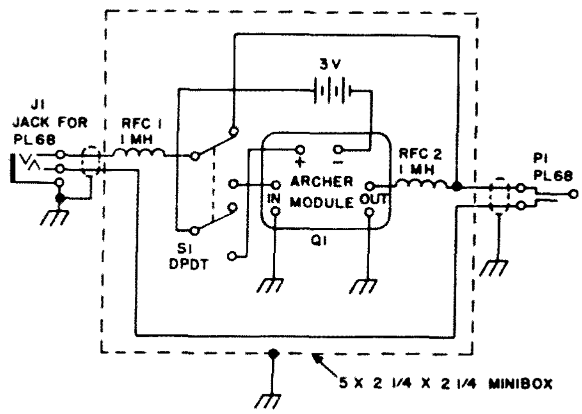


Fig. 1. Some simple precautions to be taken in the SB-34 adaptation assembly. J1—jack to fit PL68 mike plug; RFC1—1 mh rf choke; S1—DPDT toggle switch; B—two 1½ volt penlight cells in series; Q1—archer solid state module; P1—PL68; M—minibox, 5 x 2¼ x 2¼.

You can add a transistorized "S" meter circuit as an external outboard device, without modification to the SBE equipment. The only connection to the receiver is via the speaker output terminals (**Fig. 2**). The rf choke is not absolutely necessary. It was incorporated in this particular installation because of fairly long leads to an external remote wall speaker, known to gather some rf during transmit mode.

The simple PNP transistor Q1 is biased to cut off by the adjustment of the 10K pot, R2. This should be done with the circuit connected to the speaker output terminals of the SBE-34, but with no signal present.

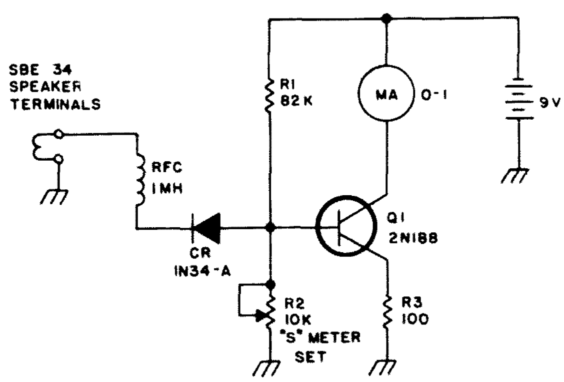


Fig. 2. Adding a transistorized S meter circuit as an outboard device. The only connection to the receiver is via the speaker output terminals. RFC—1 mh rf choke; CR—IN34-A germanium diode; R1—82K; R2—10K (S-meter set); R3—100Ω; Q1—PNP 6-9 volt audio type transistor Radio Shack Archer type 276-403 or type 2N188, SK 3004 (RCA); M—Radio Shack Micronta 0-1 mil "S" meter model 22-020 or 22-004.

The audio output fed to the germanium diode is rectified by the 1N34-A. The resultant pulsating dc causes Q1 to conduct. The "S" meter measuring the collector current of the transistor will swing in proportion to the relative strength of audio signals.

Isn't the strength of the "S" meter reading dependent upon the setting of the receiver gain control? The answer is "yes," but it's not as much of a disadvantage as you might think. For example, at any given setting a group of signals on a round table will fall into their proper perspective as related one to the other. At normal comfortable room volume, the readings on strong signals compare favorably with any other "S" meter.

Resounding audio thumps from switching transients are heard in the loud speaker when changing the SBE equipment from receive to transmit mode, and back again. You can substantially reduce, or eliminate this completely depending upon which of the following two methods you choose to employ. If you operate VOX or use your 34 barefoot, try Method 1. If you prefer push to talk, and especially if you also use a

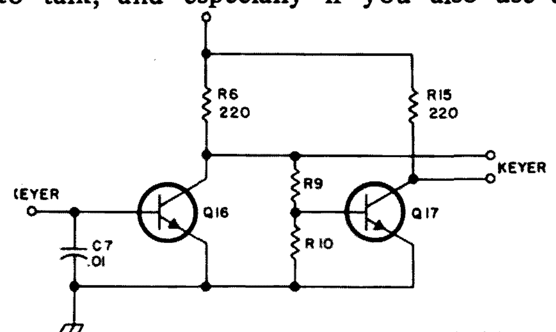


Fig. 3. A portion of the SB-34 switching circuitry.

linear, choose Method 2, for reasons that will become apparent.

Refer to **Fig.** 3 for a portion of the SB-34 switching circuitry. Method 1 involves experimental by-passing of the collector circuits of both switching transistors, Q16 and Q17, using large values of capacitance. The values required may vary within fairly wide limits, depending upon the preference of the operator, variations from one SB-34 to another, and the inclusion or exclusion of a larger speaker in the individual shack. The results are more noticeable when only the internal built-in speaker is involved.

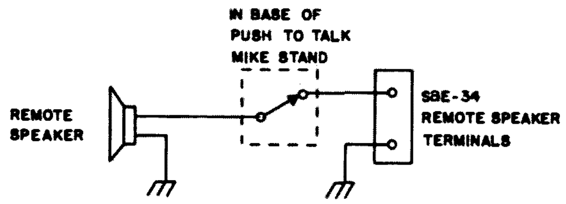


Fig. 4. How the additional circuitry is applied to the remote speaker.

Small transistor type electrolytics are used—15 to 25 volts ratings. Values from 50 to as high as 250 μf will each provide a slightly different shaping to the audio result of the keying transient.

The capacitors may be applied from either above or below the circuit board. Care should be taken to see that in each case the positive terminal of the electrolytic is connected to the transistor side of the circuit; the negative terminal goes to ground since this is required by the circuit polarity of Q16 and Q17, both NPN type transistors.

Method 2 involves a combination electronic and electro-mechanical remedy that is most effective. Many push-to-talk microphones employ a leaf spring system of switching contacts, similar to a relay. In the Shure 444, for example, there is plenty of room in the base for additional switching contacts. New ones can be fabricated by pulling them off a relay discarded in the junk box. A rubber chassis grommet on the tip of the new leaf spring allows contact by the plastic push to talk bar slightly in advance of normal switching contact. **Fig. 4** shows how this additional circuitry is applied to the SB-34's remote speaker.

In method 2, a 25 volt, 50 μf transistor electrolytic is also applied from collector to ground on keyer Q17. It was included in the push to talk application to soften any remaining switching transient audible on those occasions when the operator's hand too roughly contacts the mike base switching bar. When even pressure is applied, the new switching contacts do their job of silencing the speaker before the transient takes place, returning the speaker to life, post transient. Result: barefoot SB-34, completely silent switching. Add the linear and all you'll hear is the soft reassuring click of the antenna relay.

. . . W6JDD

Antenna Fishing

Most hams of my acquaintance would like to have a 100 foot self-supporting tilt-over tower for their antennas. However many of us are not numbered among those that do. Therefore we must make do with what our finances, premises, landlords, and ultimately our XYL's will allow.

At my former QTH I was blessed (or cursed) with several tall oak trees which were pressed into service. These trees went some 30 feet to the first limb and at the 80 foot level one of them had a large limb that overhung an open place in the backyard. This limb was used as the support for my 80 meter inverted V and 40 meter ground-plane antennas.

Whenever a friend came over to visit for the first time the question was invariably asked, "How did you ever get that antenna way up there?" To which I always answered, "With my fishing pole." This often resulted in a look of disbelief. Actually it is very simple and quite effective and works as follows:

I take my open faced spinning outfit and put a small sinker on it. An experienced angler will be able to tell what size. A sinker too small will result in it falling short because of lack of weight. A sinker too large will not work because the rod cannot provide enough whip action to propel it high enough. I would stand approximately 20 feet from directly underneath the limb and cast the sinker over the limb. Usually several tries were necessary as you are casting almost vertically. After the sinker and line were over the limb and returned to the ground I removed the sinker and replaced it with the end of a spool of nylon fishing line of the type used for trotlines. Cotton line such as used for plumb lines may be used but is not as strong.

The monofilament line is then reeled back on the spinning reel, pulling the nylon line back over the limb. When the heavier line is over the limb and back down to ground level it is tied to a rope, polypropylene is best. Remember that both the nylon line and the rope must be at least twice as long as the limb is high. The nylon line is then pulled back over the limb, pulling the rope over after it. This rope is used to pull up and lower the antenna or antennas.

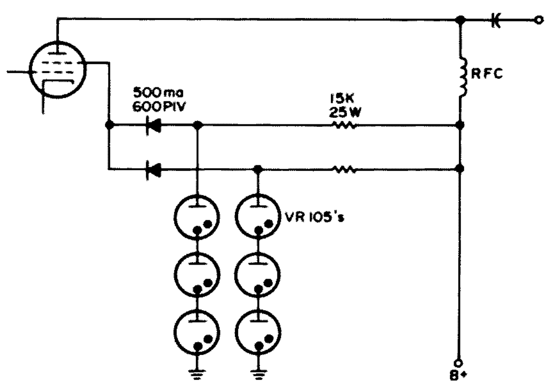
I found this system to be very satisfactory and more effective than other methods I tried to get the line over the limb, such as weight and line and bow and arrow to name a couple. A couple of pointers, however, to those interested in trying it. When tying the nylon line to the rope tie the knot in such a way to lessen the chances for the knot to hang up on the limb. Wrapping the knot with plastic tape helps. Secondly, the polypropylene rope is strongly recommended because of its strength and resistance to weather and rot. It can be purchased at most any sporting goods store.

As I said before, we all might prefer a 100 foot self-supporting tilt-over tower, but as the saying goes, "Beggars can't be choosers."

Norman Ralph W4AYI/5

More Current from VR Tubes

You can always operate VR-tubes in series to get higher regulated voltages, but what can you do when you need more current? If you put the VR's in parallel, when one branch ignites, the voltage is too low to ignite the other. A neat solution was found



while designing a 4X150 linear: 2 diodes solve the problem by acting as switches. We used 500 ma, 600 PIV diodes as they were on hand.

Curtis Goodson, W4QBU

continued from page 2
changes, he has not written to me. For that matter I can recall darned few ever in favor of the first stage. My mail is 100% opposed to further changes. The letters I get complain that the fragmentation of our CW bands has essentially emptied them and that the commercials are moving in. There are far too many of these letters for them to be taken lightly.

The FCC figures on new Extra Class licenses issued are not in any way encouraging. Outside of the few thousand Extras that were originally "grandfathered" in, few operators have shown much interest in taking the test. To be specific, in June 139 Extra Class licenses were issued, in May 133, in April 190, in March 136, in February 145, etc. When you figure that the latest FCC list shows 262,052 licenses amateurs, with about 9000 of these being Extras and only 130 or so being added per month, you can appreciate the total rejection that this demonstrated. It is completely insignificant.

While a large number of amateurs agree with the principle of Incentive Licensing. few appreciate its actuality. They resent having to go back to school and learn a lot of theory that will be of little actual value to them in order to take the new license exam and thus retain the frequencies they feel that they had already earned. They resent having to pay the additional examination fee and having to make the trip to the FCC examining point and suffering the nervousness and tension of the test. They even more resent having to go down a second and third time . . . as a great many do . . . when they fail it the first time. What an embarassment that is!

All this has had an effect on QST, which engineered and drove through the rules changes. Subscriptions have been dropping of at an alarming rate and dissatisfaction with the power elite running the show is getting out of hand. Something must be done, obviously. My guess is that QST has already decided to ask the FCC to put off the second stage of the rules changes and that the board meeting has been called to rubber-stamp this decision. I doubt (wistfully) that the directors have the ability or the influence to bring about the real changes that are needed. Too many of them are deathfully afraid of offending HQ and we will probably see as much rocking of the boat as has been in evidence in the last several years . . . namely, very little.

There is no harm whatever in your dropping a letter to the director of your area (see page 8 of QST) and expressing your own convictions as to the changes that should be made. Should we continue to be split up as we are now or go back as we were to one relatively happy family with equal QRM for everyone? Since the director has no way of knowing for sure whether you are a QST subscriber or not is no reason why you should let this deter you.

There seems to be little opposition to the opening of new bands for the higher licenses. This is consistent with the concept of giving something in return for effort rather than taking it away if the effort is not made. The reward system as opposed to the punishment system. 14150-14200 could easily be opened for phone. How about 7050-7150? 28100-28500? Etc. The gradual change from predominantly CW to predominantly phone operation has not been followed by band allocations and CW is presently allocated frequencies all out of proportion to the occupancy on several bands.

Write the FCC

If you like the present allocations then now is the time to write to the FCC and tell them so. If you believe that the proposed changes for November 22nd will be beneficial, tell them about it. If you feel that the system is all wrong, write to them about that. Make yourself heard.

And just in case QST does have the inside track, they think they have to write to your area director and tell him the same thing.

Public Relations

A survey of the method of introduction of newcomers to amateur radio has shown that most of them have come to us through fellow amateurs rather than through interest sparked by magazine or newspaper articles. This is rather obvious when you consider the vacuum we have had in public relations. You can't tell me that advertising doesn't work. It does work and it works well . . . when it is used.

We need publicity. Publicity is advertising that is free. We have hundreds of fascinating stories to tell and, with a good PR man organizing it, we could have articles in every major magazine and interest thousands of dollars upon thousands of people in our wonderful hobby. QST has hundreds of thousands of dollars just lying around doing no one any good. Some of this money could easily be invested in a reasonable stock or mutual fund and the earnings used to buy PR for amateur radio so we could be sure that our hobby would grow.

QST Investments

A fascinating part of the yearly report from QST is the information on their investments. If I had an investment councilor that turned in the rotten performance they have experienced I would start looking for a sticky finger in the till. They had about $575,000 in cash and securities at the beginning of 1968 and ended up with only $618,000. Since about $35,000 of the "profit" went for inflation, they ended up with peanuts. This was a whole lot better than the year before when they came up with about 1½% profit *before* considering inflation.

At the same time as the QST financial situation was staying put, the stock market was going to new highs. The ISEC model fund rose about 80% during the period and few prudent investors made less than 50% on their investments.

Perhaps, while you are writing or calling your director, you might ask him to account for this situation. This might just goad him into bringing up the matter at the November meeting and getting something done about it. While some investors are

making millions out of nest eggs a lot smaller than the $500,000 or so QST has in its pocket, amateur radio is hurting and hurting badly for money to invest in its future.

With money we could have public relations and get amateur radio growing. We could put the pressure on internationally and help to keep our bands at the next ITU conference. We could organize mass shipments of old gear to poverty countries to get thousands of new amateurs on the air around the world. We could even open an office in Washington and thus invest in our survival here at home.

Are your directors representing you or are they merely glorified QST Subscription Agents? Make them do some work! Make them represent you and give you answers to your questions. If they won't work or answer questions, throw them out and get in some that will.

QST Quote on the FCC

September QST says, "...the amateur division of FCC consists of one man who is about to retire and wants no trouble." This is in print! It is in an editorial! This is certainly a strange follow up on the article by W4GF (FCC Amateur Division) in the August QST and requires some explanation. What was their motive in printing this scurrilous item? It is billed as something someone said that someone else said, however since they made no effort to check in any way, we can only assume that in their usual round about way they are trying to tell us something.

My own feeling on the matter is that QST is guilty of exaggeration. Since they do not have an office in Washington and are not representing amateur radio there, dealing with that agency only through a part time attorney, it is obvious that they are dangerously out of touch with reality. The FCC, like any other government agency, will give amateur radio as much attention as it demands of them. When we are almost completely silent we are going to be forgotten and are going to be ignored. This can lead to rules changes which are poorly thought out, like the incentive licensing rules. When, many of us want to know, will ARRL stop spending the members money almost entirely on publishing and start providing some representation? Let's stop taking digs at the FCC in QST and open an office in Washington for the good of amateur radio!

ARRL National Convention Report

Chuck Boegel WØCVU (a very active and well known ham) has been sending us copies of his correspondence with ARRL HQ on the subject of the 1969 ARRL National Convention in Des Moines. He seems to have some very legitimate gripes about the way he and several other well known amateurs were treated at the convention (including the past president of the ARRL). He has gone on to ask for an accounting of the funds of the convention and has so far found his letters ignored by the organizers of the convention and ARRL HQ. The major organizer was, he says, the president of the ARRL, Robert Denniston. I am sure that this must all be a mistake and that ARRL president Denniston will publish the full facts of the financial accounting of the convention. I was disappointed to find out from Chuck that the Eye-Bank net boys were charged $150 for the little room they had to show the work they are doing. If this is true it is shameful. Chuck mentioned having a copy of a letter from Huntoon saying that ARRL does not expect to get an accounting of the funds from the National Convention. Little was given away in prizes, so there should be a handsome profit for the Des Moines Radio Club....or someone. Let's hear more about this one ARRL.

ARRL Articles of Association Waived

Though Article 12 of the ARRL Articles of Association says, "No person shall be eligible for the office of Director, Vice-Director, President or Vice-President who is...commercially engaged in the publication of radio literature intended in whole or in part for consumption by radio amateurs," I see that Ralph Anderson KØNL has made it as a Vice-Director. Since Ralph is publishing two magazines for radio amateurs, both on a commercial basis, complete with ads and subscription fees, perhaps I can run for Director now? Ralph has been accepting paid commercial ads in his magazines for years and, as far as I know, he is presently devoting just about full time to their publication. Full or part time, the magazines are obviously commercial and everyone at ARRL knows it and has, in flagrant violation of the Articles of Association, overlooked the rules. Please ask your Director about this one.

Disaster Communications

In the early days of amateur radio we enjoyed a virtual monopoly as two-way radio operators. In times of emergency there just was no place else to turn for radio communication.

While we still have long range communications pretty well to ourselves, we should recognize that local communications systems are well developed these days and perfectly capable of handling many of the emergencies that used to fall automatically to amateurs.

We can take advantage of this situation, once we recognize it and adjust to it. If, instead of competing or fighting with the other services to provide local communications, we worked to organize them and tie them in with the longer range communications that only amateur radio can provide, the result would be a better total service and a commanding position for amateur radio.

Communications during most disasters requires local coverage to help officials direct the efforts and know what the results are of their directions. Officials from outside the local area also need to know what is happening so they can coordinate their efforts to bring in help and supplies.

While amateur radio might be able to handle the whole situation in larger areas where we have plenty of mobile units to use, in most emergencies we can well use the help of other mobile

two-way operators such as CB, taxi, police, fire, doctors, and others. We can provide a very valuable service in coordinating communications between the various two-way users. This might take the form of our placing a mobile or small portable station near the base station of each of the other services so we could use amateur radio as the master communicator.

Perhaps we should recognize that in the event of any serious emergency we cannot depend upon either telephone or commercial power. In many cases it will be up to us to provide power and use our system in place of the telephone.

As a first step toward setting up a workable disaster communications system it would seem to me that an inventory of the equipment, operators and power sources would be in order. Once you know the workings of the other two-way radio systems in your area you will be in a position to coordinate the ham portable and mobile stations for a truly efficient emergency service.

Under normal circumstances an operation like this would be set up under the auspices of Civil Defense. Unfortunately, in most of the reports I have received, CD is in no position whatever to undertake any real coordination. The CD has been operating for too many years with little purpose or organization, with the result that there are few outfits of any real value. No, I think that we would do a lot better if we decided to take the bull by the horns and set up our own emergency system, using our own initiative. If there is enough interest in radio clubs in getting a service like this going I will be glad to have some window decals made for the cars in order to lend an air of officialness to the effort. I suggest that we call those working this end Disaster Communications Coordinators (DCC's) and have a nice red-white and blue DCC car sticker. Comments?

Radio amateurs are the natural leaders for emergency communications because we are the only service that is everywhere and can communicate over any range. Rather than fight or ignore the other services, we should enlist their aid and get them to cooperate with us.

What do you think?

Ham Hospitality

Jock White ZL2GX, 152 Lytton Road, Gisborne, NZ and XYL are glad to meet visitors. Drop them a line if you are getting to the South Island. Jock has a desperate need for a 4D32 in case you have a good spare around. Send it as used and of no commercial value.

FCC Petition

Lowell White W2CNQ has asked that the amateur rules be amended to add some additional frequencies for SSB international contacts and for a carry-over of commercial licenses toward amateur. RM-1477.

Reade Apgar asked the Commission to amend the rules to permit AFSK RTTY 40F2 to be used in the 145.17–145.71, 146.79–147.33, and 220–225 mhz bands. RM-1478.

Paul Lee requested 3775-3800, 7175-7200, 14175-14200, 21200-21259 khz for Amateur Extra. RM-1479.

Sour DXpedition

DX'ers who are nice enough to send in donations for DX'peditions may soon fade away. I'm not speaking of Gus and his fizzled expedition, but of what appears to be a scheme by an American living in Australia to gather some loose donations by promising a trip to rare spots. It seems that Jerry VK2BFI may have taken another whack at the neck of the goose that laid the golden donation eggs with promises in Gus' DX Bulletin to visit VS5, CR8 and 2P1 (?). Now, say the bulletins, no DXpedition and no refunds. Can the goose, already badly maimed by Miller, survive much more of this?

Gus is reported to have finally given up and returned home after a number of attempts to get a repeat of his earlier DXpedition running again. Equipment failures and transportation problems seem to have scuttled him. DX'ers, depressed by the incentive licensing disaster, changes in the DXCC rules, and fake or fizzled DXpeditions, could use some good news about now.

Pay TV

On June 12th the FCC authorized a fifth TV channel for pay-TV in the 80 largest American cities which have four or more free-TV stations. I think that those of you readers who have worked in television or have read much about the inside workings of the business will agree with me that while pay-TV has a lot to offer the broadcaster, it has little to offer the customer in the long run.

Television is in the execrable state it is in today because larger audiences bring in more money. Pay-TV can't be any different. What pay-TV station is going to show an art film of interest to 5% of the viewers when he can show a sex film that will get him 65%? All that will happen is that we will accelerate the demise of our movie theaters. I somehow doubt that we will see many good movies made for television. So far every one I have seen has been dreadful. And how long will it be before we start seeing commercials on the pay-TV stations? We pay $2 to go to the movies and find that we have commercials there now! No, I believe that we will find ourselves very shortly back where we started, but having to put quarters or dollars in the television set to watch the Beverly Hillbillies.

It is possible that the members might want to know a little more about the recent $1500 donated by ARRL to a local radio club. It may well be money carefully investigated, but again, why the secrecy? The club has been run, for many years, I understand, by League officials. I know that I would like to know more about the VHF accomplishments of the club, what sort of equipment has been set up in the past for the club station, where it came from, who operates it, and what success it has had on what bands. Let's hear what the $1500 will be used for and

see occasional status reports in QST on the effort.

Writer Beware!

One of our more prolific authors complains that he submitted a manuscript for a booklet to one of the other ham magazine publishers in early 1967. A contract was signed and he was promised that the book would be published by the Fall of 1967. It was not published in 1967. During 1968 he received many letters from the editor promising publication in 1968. It still has not been published and he has been unable to get them to either publish the book or return the manuscript. What can he do?

While we too have been a little slow in publishing some of the book manuscripts that we have on hand, we have paid the authors for them on acceptance. We have been getting a new printing plant ready to produce books right here at 73 headquarters and the final piece of machinery has just been purchased and installed. We now have a Chief 22 printing press, a Rossback collator, a Baumfolder, a Boston stitcher and an Oswego paper cutter. In all we have invested about $15,000 in the new printing facility. Now all we have to do is get it working smoothly and we will have a stream of interesting books coming out for you. Authors, please take note.

RM-1346

Werner Esseluhn K3MGO has petitioned the FCC to establish a new class of license for senior citizens (60 and over) which would permit the use of crystal controlled type-accepted (no homebrew) equipment on the top end of two meters. The requirements would be five wpm code plus asimple theory and rules test. The major purpose of the new license would be to provide an activity and relief from boredom for the senior citizens.

RM-1493

Emery Mitton W6ARM has petitioned the FCC to amend the rules to change six meters so that 50.0-50.05 are for Extra and Advanced, 50.0-53.5 for telephony, and 53.5-54.0 for telegraphy. This would move the virtually unused CW band to the top end of six meters. Why not do away with it if it is not going to be used?

Five Band WAS Award

QST has announced the availability of a five band Worked All States award. This seems like a fine idea to me; I think I've plugged for just that in my past editorials.

The starting date for the award has been set for 1 January, 1970, thus giving everyone an equal fresh start at getting the award. I sure wish that the QST board had not decided to do that. I can see a lot of good reasons for setting the date at 1 January 1969 and a lot of reasons why the 1970 start is bad news.

Most important for all of us interested in DX is the impact that this decision will have on the DX operators. This is a catastrophe for many of them. The five band DXCC started in January 1969 and our DX operators have been working through all of the countries on every band as fast as they can, aiming at that award. The DX ops must cooperate with them in sending QSL's. This means that thousands of DX operators will be well on their way toward WAS by the end of this year on all five bands. They will have invested a stupendous amount of money in those QSL cards. So what happens? None of those cards are any good for the new WAS . . . they will have to start all over again! This will be an unnecessary expense. Why couldn't the date have been made retroactive to coincide with the five band DXCC date?

Those operators in the rarer states will find themselves facing a contest-type existence come January. Most of the fellows contacted in the past will now want QSL cards all over again... duplication...expense...time...and a lot of work.

Would someone like to make a rough calculation of how many cards each operator would have to send out if, say, 10,000 amateurs decide to go for the new WAS award? It will take 250 cards for the award, but each op will have to send out around 25,000 cards or so! Ops in Nevada, Delaware. Vermont, Montana, Wyoming, New Hampshire, etc., had better just buy a small printing press and get ready for the onslaught. Imagine 10,000 stations trying to work you on five different bands!

It wouldn't hurt for you to call your QST director and see whether you can get him to move that date back one year. Or ten.

Typesetting Style in 73

One of the authors got all uptight over a recent change in our style of setting type. We had gone along with the convention of setting electronic notation based upon people's names with capital letters–mA, pF, mV, kHz, etc. Recently I changed to all lower case letters and, sure enough, the angry voice of protest was heard.

Ampere, Hertz, Volta, Ohm, Faraday and the other fathers of electricity and radio have been well honored and I hope that by now very few 73 readers don't at least recognize their names. By keeping their initials in capital letters it seems to me that we are putting off the honor of letting their names go into our language. Lower case "ohm" is generic and is like taking the quotation marks off his name.

Then there is the matter of the readibility of 73 magazine. The texts on type tell us that the frequent use of capital letters slows down the speed of reading and the comprehension of the material. Just look at a page of radio text that is full of capital letters and see how cluttered it looks compared to all lower case type. Italics also slow up reading and we are working on keeping them to a minimum in 73.

It comes down to this, basically. The only thing that is unchanging about our world is change. Change is always with us. Some people fight change every inch of the way, others grudgingly go along with it. For me, I like to initiate change.

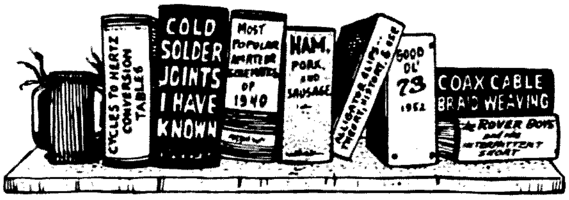
When I see something that looks like a good change, I go ahead, even in the face of traditions and convention. Isn't this really the best thing to do?

For the time being we will continue to set our mhz, pf, ma, and such. If you find that this makes the articles harder to read rather than easier, then please let me know. That, obviously, is the final test.

My books on type tell me that the Press Roman type we are using now is by far one of the easiest to read. We can change to a sans-serif type such as Univers (this is a sample of Univers type) such as is being used by Ham Radio, but it would be a lot harder to read. I adnit that it looks nice. Please advise.

In the last couple of issues we have started setting our feature articles in a nine point type spaced as if we were using eleven point type. This makes the type a little more spread out than previously and a little easier to read. Editorial articles such as this, Leaky Lines, etc., will be set in smaller type, eight point on a nine point spacing, so that they will take up less space in the magazine than feature articles.

. . . Wayne



NEW BOOKS

Radio Amateur Q & A License Guide

Ameco adds yet another book to its family of publications, this time a question and answer license guide for the prospective novice, technician, conditional or general licensee. Forty-eight pages in length, this informative manual prepares readers for the theory requirements of the above classes of amateur licenses, includes sample FCC-type tests with answers in the back of the book, and contains a wealth of schematics, illustrations and tables. Written by Martin Schwartz, the book is available for 50 cents from Ameco.

Meter Handbook

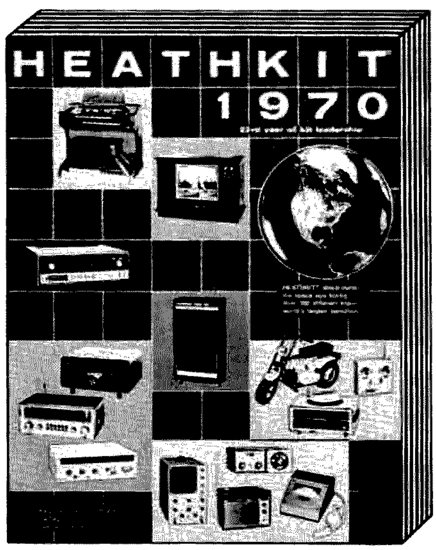
Prentice-Hall Publishers have spawned another book in their series in electronic technology. The new book is titled *Handbook of Electronic Meters Theory and Application*," written by John D. Lenk.

A worthwhile addition to the technical library of any engineer, technician or amateur, this book in one single volume explains the how's and why's of electronic meters for virtually every known practical application. Solid state and integrated circuit data, practical theory on laboratory and shop meters, testing and calibrating meters, meter principles, servicing components and circuits with meters, in addition to a host of other topics, are well treated in this highly enlightening book. There is a wealth of graphs, schematics, charts and diagrams all carefully selected to provide the reader with the ultimate in simplicity and yet being more than adequate in illustrating each point.

Mr. Lenk who has authored twenty-one other books and hundreds of articles, has put together a well researched, prepared, written and authoritative book on meters which we suggest to every user of meters.

180 pages in length, the book is sold by Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

New Heath Catalog



The 1970 edition of the Heath catalog lists over 300 kits on 116 pages. In addition to their fine line of ham gear they have CB, hi-fi, radio control, color TV, test equipment, and many other kits of interest to the amateur. Write Heath, Benton Harbor, MI 49022 and tell 'em 73 sent you.

LETTERS

Dear Wayne

I just opened the September issue of 73 and read several letters of complaint about the quality level of present-day amateurs compared with the good old days. Well, Wayne, I returned last night with the others of Twin City Hams from four 18-hour-plus days operating our club station WA5WKP/5 at the Gulfport, Miss., Red Cross HQ after Hurricane Camille. You can sleep well with the knowledge that there are plenty of hams all over the country with the true amateur spirit of cooperation and with skills which can stand comparison with those of any professional service. If the critics monitored the traffic and emergency frequencies they would have been impressed with the way the hams almost fought to take traffic and consistently demonstrated their "by the book" procedures. Our group, including several newcomers to ham radio, received the utmost consideration from everyone (with some help from FCC, of course).

No doubt you will have many stories on the disaster from those more deeply involved than me, but one impression which may be of help to those planning for future emergencies is that much more VHF gear was needed than was available for use on other than the rag-chew channels. All available frequencies were jammed on all bands, and everyone had top priority traffic.

For a long time, amateur radio was the only means of communication in the stricken area. Ham radio did an excellent job and all who participated, even by just standing by, are to be commended. Their efforts were truly appreciated by the people who needed their help. Ham radio's reputation is high in Camille Country.

Frank M. Boyd WA5QVN
713 Hinke Drive
Monroe LA 71201

Dear Sirs,

In reference to "Leaky Lines" and "What Are We Here For ' in the August 73, I would like to put in my thoughts. These articles are quite true, but have you ever listened to the Novice bands lately? On 80 it is QRM, QSB, RTTY and blank carriers being tuned up. Ditto 40. Forget 15. The Novice is so neatly boxed in and hampered and harried no wonder many would-be hams drop from the bands as their licenses expire.

My call letters tell what I know about ham radio (No Blinking Knowledge) and I make no denials that my copy is probably still 5 wpm. It is just that when a higher class operator zero beats my signal, calls me, and then goes into a 20 wpm frenzy, I want to give up. To my request to please QRS comes back, "Get the hell off the air, lid." It comes back slow and precise. I keep trying and appreciate the consideration and understanding of those who take the time to contact me and the thousands of others like me. I am almost always QSK and, for those who don't know what QSK is, you are not up to my level. Those who are anti-ARRL, CW, SSB, AM, FM, RTTY, hear me! I don't particularly agree with the ARRL policies, but those two articles should mean something to some of you so-called amateurs. The goings-on on the air should make you sick. Techs going to get onto your precious ten meter band? Maybe, but at the moment CB and business radio are after it ALL. Why? They have the most people and need to expand. You wonder what happened to 160M and 11M? You so-called amateur! Your ticket means so much. ARRL has its faults, but the real responsibility lies with you and only you. That's right, sit back and gripe, you've paid your dues and the ARRL will set everything right. I hope that ten will go CB, maybe then even the rankest of amateurs will get up and shout—will become active in the amateur affairs. We have played footsie too long with our precious amateur allocations as well as our civic responsibilities. You'd better get with it, Mr. Amateur or your hobby will go QRT.

Robert Addy WN4NBK
Sav. Terrace Apartments 27D
North Augusta SC 29841

Dear Wayne,

While reading the article on WWV in the September issue, I noticed that the coding system given is the old system which has been replaced by a newwer one. Readers desiring more information can get a 14 page booklet entitled "NBS Frequency and Time Broadcast Services" for 15 cents. Write to the Superintendent of Documents, Government Printing Office, Washington DC 20402 and ask for Sepcial Publication 236.

Lee Blanton WA8YBT
10495 Deerfield Road
Cincinnati OH 45242

Dear Wayne,

Good Grief! You wasted five good pages on amplitude modulation in September. Come now—who would use Taylor Modulation on VHF? FM is the way to go, and it does not have to be rock bound either. Even CB'ers wish they had something else instead of AM to work DX with—as they do, day in and day out.

WB6LNS/4
326 Brady Drive
Warner Robins GA 31903

Dear Wayne,

First, I must congratulate you and your staff for publishing the most exciting, interesting, and informative ham magazine available. All others are cheap imitations.

About a month ago, I sent in subscription blanks to 73, and CQ. With both, I said, "Please bill me later." From CQ I received my letter and its envelope, and a notice saying they (CQ) don't have a billing policy. 73 sent me the August edition, making me thankful for the existence of a superior magazine (73).

Your articles on gaining your Advanced, and Extra Class licenses are second to none. They are

the most informative articles ever written. I think they will greatly influence incentive licensing. Your articles are so easy to understand, I am eager to sit down and learn from them. Understanding the material gives me a sense of accomplishment. This is the boost which will get me my Extra, not band shrinking by the FCC, or the stupid actions of the %!$&!! ARRL.

Dave Eischens WA2CAF
46 Round Hill Road
Poughkeepsie NY 12603

Dear Wayne,

I subscribed to your 73 magazine recently and am quite impressed. There are three projects that I would like to see in 73. These are super-regenerative receivers for the citizen's band, for six meters and for two meters, all to be operated on 12 volts mobile. This type of receiver has many advantages and I am looking for schematics.

Vern Swedberg K9GZI
10943 South Albany
Chicago IL 60655

Sounds great for CB, but I'm not all that sure that we need more super-regens on two and six. They might be okay with pre-amps. Any readers have this worked out for Vern? Send 'em in and we can pass the circuits on to all.. ed.

Dear Wayne,

As per your request in September 1969, 73, may I submit the following information.

"Code and Theory instruction are offered by The El Cajon Amateur Radio Club, 1113 East Madison Ave., El Cajon, CA 92020."

We invite anyone from the greater San Diego Southern California area to visit with us. Regular meetings are held on the 2nd Thursday of every month where class times and schedules will be available.

Last year was our first attempt at this project and we netted 10 new Novice, one of which was my own XYL.

Thank you and 73 for your interest in developing new amateurs.

Robert Smith WB6ODR
Vice-President
El Cajon ARC

Dear Wayne,

Wow! 35 stories in one issue. Wowee. The other magazines will have to improve because of you.

George Bonadio W2WLR

Dear Sir,

Your August 69 issue was a damn good one; It finally convinced me I should subscribe. Bet you can't keep up the pace.

Joe Buswell WA5TRS
Box 10674
Midwest City, OK 73110

If the articles keep coming in we will make the magazine even bigger...ed.

Testimonial:

This letter is addressed to all non-writers. I am a non-writer.

Just a very short time ago acceptance for an article came in the mail. The number of dollars per

man-hour of research, write and rewrite time was low, but it looks like the fringe benefits are the payoff. When the notification of acceptance comes home the impact on you is great, but the impact on others is out of this world. Where once they "laughed when you sat down to type," the typewriter is left in a convenient place with cleared chair and blank paper. You sit down to tiddle with the keys a little and the house becomes quiet where you are. In a little while someone brings you coffee (or tea) and asks if everything is okay.

The guys at the club and on the job look at the acceptance verification form and change their minds a little about you. At least they say so–which becomes the most beautiful music you ever heard. Suddenly people begin to wonder what they have said or done that you might write about next. People are nice if they think the whole world will find out if they are not.

When your paper is published, then come the invitations to speak, to lecture, to give interviews to a greater or lesser degree. This gives you a little taste of celebrity action.

So, if this sounds good to you and you want to "become a prophet in your own country,' Write! Every ham has to have some brains and probably is involved in something that would be of interest to other hams. Write about it and send it to 73. This Green guy is just smart enough to print it–and I want to read it. If he keeps printing this stuff the magazine will become one of the Must Magazines for every High School and College library in the nation. And for the future of ham radio that can't hurt....and that is an understatement.

Bill Hounsell W5OUK
220 Fannin
Refugio, TX 78377

Not a few authors have written to say that their articles in 73 went a long way toward getting them a better job... ed.

Dear Wayne,

I am interested in being on the T.A.G. for your new Novice magazine. I can handle General Help, and "Problems with Rigs."

Readers with questions *must* send a SASE! I use up enough money for QSL stamps!

The Advanced Class book was great! I finished my Advanced in half the time I used on the General (and passed)!

Jon Teich WB2JAE
22 Olden Road
Edison, NJ 08817

Dear Wayne,

I have some suggestions for the authors in 73. What do hams use? By an overwhelming majority they use "appliances." So why not make your magazine different from the 1920 type QST by featuring articles on manufactured gear? How about articles on how to keep from burning up your horizontal oscillator finals in less than seven seconds–the best way to get a store-boughten receiver, transmitter or transceiver–ham transmitters and receivers from around the world–shipping: REA, PP, bus, UPS or the various air deliveries–contents of an appliance operator's tool kit–antennas–how I established a good ground system–the 34NB noise blanker–souping up the Swan 250–how to get a 100 foot mast up when you're on the road from Friday until Monday or vice versa–test equipment–broadband receivers–how to tell if your finals are soft–how to align your transceiver–what to do if your new equipment arrives all beat up and not insured–fixing up that old KWS-1–what each company will do under the terms of its warranty–window ledge antennas for 10-15-20– let's upset the ARRL by getting them to take a poll via QST on important issues such as incentive licensing–the scent is obnoxious, you know–how do ham radio stores decide the trade-in figure they give you–how to make a cheap VHF or UHF receiver–where to locate the ham shack (from the XYL's point of view–what country is KC4USV/KC4 in?–why I can copy much faster in my head than I can write or do on the mill–tri-band yagi vs a good 40M quad–can 75M ever be retrieved from the over-redundant nets?–the increasing presence of retired hams on the bands and why didn't they choose something else?–hamming with a pickup camper–with a trailer–mobile home–TVI cases and litigation–census of hams who also use CB–operating a rig from your office–how to work out TVI with a neighbor.

There are many more subjects, but it is now Saturday afternoon and I have to go down to the office and open it up to see a child who has had diarrhea for two weeks....should adults be allowed to have children?

Arthur Woods W4GJW
201 Second Avenue SE
Cullman AL 35055

With 40 articles or so a month we can certainly use info on all of those items you suggested Art. I hope this will get some prospective authors busy at their typewriters.. ed.

Dear Wayne,

Why did you print the letter (Sept. '69 issue) from Mr. Diamond, "Radio KALX?" The man quite patently doesn't know what he's talking about. Please be advised that the Amateur Extra Exam is on a par in every way with the Commercial First Phone Exam; in fact, most of the exam material is the same.

Furthermore, the average amateur ticket holder got his Extra (or other license) on his own, via the school of Hard Knocks–not through formal education, or a correspondence course that guaranteed "a first class license or your money back." I know many First Phone men who are first class dunderheads, including many low-paid, so-called "Chief Engineers." The First Phone license just doesn't hold that much prestige!

I do agree with Mr. Diamond on one point, however: Ham radio seems to have lost its charm and its pride, now that it's relegated to the manipulation of dials on a transceiver–but to say that the amateur exam is "hardly a test at all" compared to the First 'Phone exam, is pure drivel.

O. R. Heinz III K7KHA
2530 Tybo Avenue
Reno, NV 89502

Dear Mr. Green:

The article "What Are We Here For?" by Mr. Grenell, ex-W8RHR, in the August issue was quite interesting. Many articles have been printed relative to amateur radio's continued existence; however, this gets closer to the bone than any I have seen thus far.

I have been a "paid communicator" since 1955 and obtained my amateur call during the summer of 1968. Presently, I am involved in emergency communications planning for the state of Texas and, as such, have also inherited the position of State RACES Radio Officer.

The many magazines and periodicals crossing my desk continually plead for relief of the crowded rf spectrum. Professional communications journals tell of the efforts made by the broadcast industry to prevent the take-over of their part of the bands. High-powered, high-paid individuals are arguing in defense of the TV spectrum loss which seems inevitable. It isn't just loss of spectrum which concerns them; it is bread-and-butter. Money seems to be of less concern than ever before to these individuals and corporations fighting in a last ditch effort.

With all this resistance (not in ohms) being met, will the FCC look elsewhere to provide frequencies which are sorely needed?

J. R. Messenger WA5VTO
Technical Operations Officer
Texas Department of Public Safety

Dear Wayne,

Last night I browsed through the September issue and was REALLY impressed. Especially by the "Light Naturally Runs Down" article. I would rather see material like that in 73 than in the Scientific American where one might naturally expect to find it. This is the kind of article that will impress my generation simply because it stimulates the imagination (not trying to sound trite).

Bill Kellogg
10000 Rushing Road
El Paso, TX 79924

Grounds

Dear Wayne,

I have been reading 73 Magazine since you started and can say without reservation that it has the highest caliber technical articles of the "big three." This is the first time I have felt compelled to comment critically on anything you have published. I work as a consulting engineer, specializing in the area of electro-magnetic interference, and you would be surprised how many engineers and multi-degreed scientists do not understand grounding and shielding, how it works, or the techniques involved in interference suppression. Even in today's sophisticated missile and space programs, some of the worst problems occur because of where, what, and how to ground. If the "pros" can get fouled up with their grounds, it is not surprising that a lot of mis-impressions exist among amateurs.

W2EEY/1's article in the September issue describes a very practical method of checking shield effectiveness. The communications receiver is probably the best test instrument the ham has and I would like to see other articles on its uses—such as in locating parasitics in transmitters, locating leaks in rf shields, etc. However, he does create the impression that all currents induced in a shield are bad, and that single point grounding is the greatest thing since canned beer. Unfortunately, it's not that simple—and that's what keeps me in business.

Single point grounding is most effective in low-level, direct-current servo mechanisms and

instrumentation systems where "ground loops" cause unbalance, bias, or off-set errors. It is important to remember that the culprit here is not magnetically induced current in the shield, but minute voltage differences between the ground tie points which result in a current flow along the shield, which in turn induces a voltage into the signal conductor. (The shield is seldom used for the return circuit.)

Single point grounding is also effective in audio frequency and power circuits, but as frequencies go up, the effectiveness of the single point ground goes down untill we reach radio frequencies where it is often worse than no shield at all!

In using single point grounds (such as in phone amplifiers or audio stages of a transmitter) it is pretty much cut and try as to which end of the shield to ground, but usually it works best to ground shields at the source end for low-level signals and at the load end for high-level signals.

Since many audio circuits are susceptible to rf pickup, it may be necessary to provide protection from both types of interference. One method is to ground one end of the shield (audio) and by-pass the other end with a .01 μf capacitor (rf). Definitely *don't* use an rf choke (per W2EEY) unless you plan to use the shield, adding the rf shield over the audio shielded cable (with insulation between, of course).

In rf work the effectiveness of a shield is directly related to how "close" it is to "ground." This is why so much emphasis is place on long ground rods, heavy copper or aluminum busses for bringing ground into the shack, and making solid, short, low-resistance connections to it. In rf grounding, the closest and shortest is the best.

To illustrate why multiple point grounding is used in rf work, visualize a shielded wire, carrying a signal, but with the shield *not* connected in any manner whatsoever. An interfering magnetic field can pass through the shield as though it were not there, and induce an interfering current directly into the center conductor. Now ground both ends of the shield and we have a completed path where the interfering signal can induce a current flow in the shield. This current is accompanied by its own magnetic field which is such as to cancel or neutralize the interfering field *inside* the shielded cable. The result then, is that the current due to the interfering field flows harmlessly to ground instead of in the center conductor. What does this do to the signal current in the shield? Nothing. If you want to talk "skin effect," the signal current is on the inside surface of the shield and the interfering current is on the outside surface. But it is easier to just parody Gertrude Stein and say, "A ground is a ground is a ground . . . ," rf ground that is. So endeth the reading of the lesson.

Earl Burdick WA6BDN
1620 Benedict Canyon
Beverly Hills, CA 90210

Dear Wayne,

I believe I might have accomplished a "first" for amateur radio. You be the judge of that

While operating in the South China Sea I held a 30 minute QSO on July 29, 1969 using my call K7WPC/mm and worked WB4KST/mm on the USS Merideth. On July 27th (first QSO!) I worked WA2YQB/mm aboard the USS Biddle. Our frequency: TEN khz. Our distance–about one mile. The rig was a pair of 810's to a transducer (Navy name is the AN/UQC-1, called the "Gertrude!" The mode was both CW/LSB, about 1200 watts. The medium, of course, was water instead of air. How about that for a QSO? Whether or not it is a first for us, somebody may get a laugh out of it.

Scott Gray K7WPC
AS Div. c/o FPO
San Francisco, CA 96601

Dear Sir:

I would like to thank you for the terrific work you have done on the Advanced Class Study Course and now the Extra. Because of you I got my Advanced license.

John C. Koning WB6VQE
4680 Crestview Drive
Norco, CA 91760

Gentlemen!

The members of The Mid Island Radio Club are shown here . . . top row–WB2MBU, WA2LJS, WB2CZL, K2LCK, W2MFI, W2PLQ. Middle row–WA2CSE, W2OIE, W2SEU. Front row–W2SMQ, W2VL.

The Mid Island Radio Club, formed in 1946, is active in Teletype, HF, and VHF, and meet on Sunday mornings, at 1000 around 3940, and at 1030 on 146.52 with RTTY and AM modes. Members meet twice monthly at members homes. The Club has been active in supplying Teletype equipment to NY hams through an arrangement with several major common carrier communications companies. When available, such equipment is distributed for a nominal fee for transportation costs. Information on equipment availability is disseminated thru the Club nets. Contact any member for information on membership or equipment.

Bill McNally WB2MBU
Secretary, Mid Island Radio Club
35 Laurel Street
Floral Park, NY 11001

Anyone else Novicing people?

Later Findings

Gentlemen:

Since the "Super Gain Antenna for 40 Meters" (October 73) was written, more sophistication has been applied to the evaluation of the antenna. In the article, I had only S-meter signal strength

measuring capability in the HF bands, and although I tried to keep the receiver calibrated, it varied considerably. Out of necessity, I developed rather sophisticated antenna gain measuring instrumentation which measures true antenna gain, including ground effects, losses in the installation site, and reflection gain. This instrument is a synchronous comparator, which compares the antenna under test, to a reference antenna, 60 times a second, and measures the long term integrated signal difference from the two antennas. The instrument is capable of 1/4 db accuracy, provided each antenna is exactly adjusted to precisely the same impedance at the comparator, so there are no reflection losses. An rf bridge is used to adjust the antenna impedances accurately.

Using this instrument I found that the description of the antenna in my article is a reasonable representation of performance when compared to antennas that are relatively high above ground, as is usual for DX antennas. Further data using a conventional high radiation angle antenna for reference is given later.

Effect of Reflectors

Accurate gain measurements revealed that the 3 wire reflector version is not perfect, since the ground reflection is enough different from perfect to decrease gain by about 1 db. A perfect reflector is 2" mesh screen covering the ground. A five wire reflector system comes within about 1/2 db of perfection, however. The biggest effect of inadequate perfection in the reflector is in shifting the electrical length of the driven element. With a 3 wire reflector the driven element is appreciably shorter than usual, and the length for resonance gradually lenghtens as more perfect reflection is attained, until about 13 wires, spaced a foot apart are laid down. With the 13 wire reflector, or with a chicken wire screen, 12 feet wide, under the antenna, the length is very close to that normal for a high dipole.

Gain is "all there" with a five wire reflector, but the resonant length of the driven element is still shortened, and the degree of shortening is easiest found experimentally. Therefore, more than five wires spaced about three feet apart is not really necessary.

Incidentally, according to wave theory, reflecting wires spaced 1/10 wave apart are seen as a solid reflector by a wave, and a reflector made of wires of .05 wavelength separation is not normally discernable from a solid metal reflector. However, my measurements with the antennas here, show that if a lossy or reactive material is immediately behind the reflecting wires, then the wires must be about .01 wavelength apart to completely shield the lossy material. With an inadequate reflector, there appears to be a strong image from the reflector wires sufficient to obtain almost all the gain possible, but a weaker image from the unshielded ground is still capable of shifting the electrical length of the dipole.

In summary, it all boils down to this: A 3 wire reflector works pretty well provided you use the correct dipole length specified in the article. Five wires give all the gain you'll get, and requires a slightly longer dipole, and 13 wires, or a chicken wire screen is the ultimate, and requires a regular length dipole.

Performance vs. an Optimum Height Dipole

While the gain of this antenna is considerable when compared to a high antenna, I decided to test it against a reference dipole antenna with height optimized for vertical radiation. A half wave dipole a quarter wave above ground is the best antenna for vertical radiation that is described in the literature. The pattern maxima is straight up, which is just what is required.

Regular antenna theory shows that such an antenna 1/4 wave about a perfect reflecting surface has a gain of 5 db above a dipole in free space. (This gain is attained only straight up into the sky, however.) So, I constructed a folded network, and compared many, many signals received from all over, via the two antennas, using the synchronous comparator. The super gain antenna consistently had about 2 db gain over this optimum height dipole, and rejected long distance QRM about 3 db better than did the reference dipole. Incidentally, hidden away in all these data is proof of the fact that a high antenna has large effective gain for long distance signals, ranging up to about 20 db when the ionosphere is weak and won't bounce high angle signals, and the converse fact, that a low antenna has large gain over a high one for short to moderate distance work.

For those hams with a venturesome soul, an inexpensive 40 meter super gain kit will be made up in small quantity to speed you on the way to trying this efficient new antenna concept. Features of the antenna are nice gain, and no need to rotate it. Since your signal bounces almost vertically off the sky, it's practically omnidirectional. Stations on the ground are looking at the image of your antenna in the ionosphere some 200 miles up and due to the high angle involved, they see the broadside of the image regardless of compass direction relative to the dipole on the ground. In addition, and antenna this close to the ground with such high efficiency and gain has some obvious advantages to hams, not the least of which is easy concealment.

E. Dusina W4NVK
571 Orange Avenue West
Melbourne, FL 32901

Dear Wayne,

If the ARRL provided its members with any of the services that most national societies provide, I would pay $10 gladly, but the ARRL's main job seems to be to put out a magazine and kill off competition. Renew my membership? When Hell freezes over!

Mike Czuhajewski WA8MCQ
Route 3
Paw Paw, MI 49079

Wash your typewriter out with soap . . . ed.

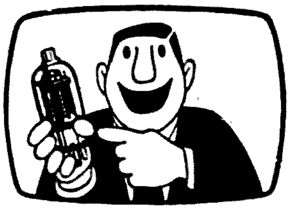
Dear Wayne,

It took incentive licensing to get me into ham radio and I expect to go for Extra Class when I pass the two year limit next August. I'm loyal to ARRL, CW, traffic handling, the low frequency end of 80M and my American Morse heritage. But I like your unpompous, irreverent style, your fighting spirit and your magazine. I don't expect to find you at the Antique Wireless Association conference October 3-5, but I think it would be very interesting if I could.

Dick Loveland WA3LAK
6808 Henry Avenue
Philadelphia PA 19128

I'll be on a hunting trip in Canada, sorry!

(continued on page 70)



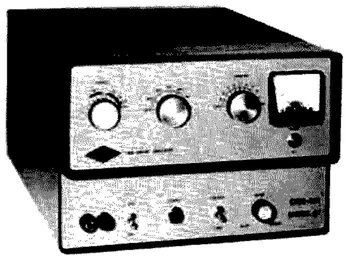
NEW PRODUCTS

Gonset GSB-201 Mark IV

The GONSET division of Aerotron, Inc., of Raleigh, North Carolina announces the new GSB-201 Mark IV, Grounded Grid Linear Amplifier for the Amateur Radio Service.

The GSB-201 Mark IV is capable of the maximum legal input of 2000 Watts of peak-envelope power in the 10, 15, 20, 40, and 80-meter bands. Four husky carbon anode type 572B tubes are employed, together with long life silicon diodes in a full wave bridge power supply (not voltage doubler). A built-in bias & high voltage supply is featured, together with a universal antenna changeover relay, with unique circuitry that permits it to be used either for transceiver use, or independent receiver and transmitter-equipped stations. In addition, the built-in power supply may be used either on 110 or 220 Volts 50/60 hz. A built-in cooling fan operates only while transmitting.

No additional or external relays or power supplies are required when the unit is used either with transceiver or separate receiver-transmitter-equipped stations. The GSB-201 Mark IV is 8½ inches High.....12 5/8 inches Wide.....17 inches Deep...and weighs 73 lbs.



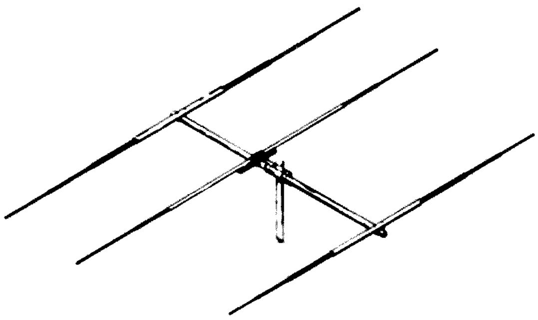
Descriptive literature for the GONSET GSB-201 Mark IV Linear Amplifier is available from Aerotron's "Award-Winning" plant in Raleigh, North Carolina.

Galaxy FM-210

Galaxy Electronics has announced their new two meter FM transceiver which will

net at just under $200. This unit should help spark even more interest in FM. This transceiver is fully solid-state, with an FET front end. It operates from 12 volts. It runs five watts input and has three crystal controlled channels. It will run either narrow or wide-band FM. An accessory power booster (10 watts input) is available for $40 extra. Watch for the ads or write to Galaxy, Council Bluffs IA 51501 for info. What can it hurt if you give 73 a little mention?

Mosley Single Band Beams



Mosley Electronics has announced two new single band beams, the Classic 10 and the Classic 15. These both use the new Mosley patented balanced capacitive matching system, the Classic Feed. They have a forward gain of about 8 db and a front-to-back ratio of about 20 to 25 db. 52 ohm feed and a kw rating. Weight is about 21 lbs. and 30 lbs. Priced at $57.64 and $66.50. Both beams are broadly resonant and can be used over the entire bands without difficulty. Write Mosley for full details. 4610 N. Lindbergh, Bridgeton, MO 63042.

Printed Circuit Boards Available

Dirck Spicer, 11 Ridgeland Road, Wallingford, CT 06492, has printed circuit boards available for the WB6BIH Stable HF VFO, July 73, page 128. The three boards are available from Spicer for $4.50 and are for use with a Heath DX-40 or any other crystal controlled transmitter. Ask for number 10221.

Spicer also has 10231 available at $2 postpaid, the Novice FET converter from the December 73 (1968). The Super Simple VFO in the July 73 (page 71) is only $.35 pp.

PROPAGATION CHART

J. H. Nelson

November 1969

SUN	MON	TUES	WED	THUR	FRI	SAT
						1
2	3	4	5	6	7	8
9	$\boxed{10}$	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7	7	7	7	3A	7	14	14	21	21
ARGENTINA	21	14	14	14	7	7A	21	21A	21A	21A	21A	21
AUSTRALIA	21	14	14	7B	7B	7B	7B	14A	14A	14	21	21A
CANAL ZONE	21	14	7	7	7	7	14A	21A	21A	21A	21A	21
ENGLAND	7	7	7	7	7	7A	14A	21A	21A	21	21	14
HAWAII	21A	14	7B	7B	7	7	7	7B	14	21A	28	21A
INDIA	7	7B	7B	7B	7B	7B	14	21	14	14	14B	7B
JAPAN	14	14	7B	7B	7B	7	7	7	7B	7B	14	21
MEXICO	14A	14	7	7	7	7	14	21	21A	21A	21A	21
PHILIPPINES	14	14	7B	7B	7B	7B	7B	7B	14	14	14B	14
PUERTO RICO	14	7	7	7	7	7	14	21	21	21	21	21
SOUTH AFRICA	14	14B	7	7B	7B	14	21A	28	28	28	21A	21
U. S. S. R.	7	7	7	7	7B	14B	14A	21	21	14	14	14B
WEST COAST	21	14	7A	7	7	7	7	14	21	21A	21A	21

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7A	7	7	7	3A	7	14	21	21	21
ARGENTINA	21	14	14	14	7	7	14	21A	21A	21A	21A	21
AUSTRALIA	28	21	14	14	7B	7B	7B	14	14A	14	21	21A
CANAL ZONE	21	14	7A	7	7	7	14	21A	21A	28	28	21A
ENGLAND	7B	7	7	7	7	7B	7B	14A	21	21	14	14B
HAWAII	21A	21	14	7B	7	7	7	7	14	21A	28	28
INDIA	14	14	7B	7B	7B	7B	7B	14	14	14	14B	7B
JAPAN	21	14	7B	7B	7B	7	7	7	7	7B	14	21
MEXICO	14	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	14	14B	7B	7B	7B	7B	7B	14	14	14	21
PUERTO RICO	21	14	7	7	7	7	14	21	21A	21A	21A	21
SOUTH AFRICA	14	14B	7	7B	7B	7B	14	21A	28	21A	21A	21
U. S. S. R.	7B	7	7	7	7B	7B	14B	14	14A	14	14	14B

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7A	7	7	7	7	7	14	14	21	21
ARGENTINA	21	21	14	14	14	7	7B	14A	21A	21A	21A	21
AUSTRALIA	28	28	21	14	14	7A	7B	7B	14	14	21	21A
CANAL ZONE	21A	21	14	14	7	7	7	14A	21A	28	28	21A
ENGLAND	7B	7B	7	7	7	7B	7B	14	14	21	14	14B
HAWAII	28	28	21	14	7A	7	7	7	14	21A	28	28
INDIA	14	14A	14	7B	7B	7B	7B	7B	14	14	14	7B
JAPAN	21	21	14	7B	7B	7	7	7	7	7B	14	21
MEXICO	21	14	7	7	7	7	7	14	21	21	21	21A
PHILIPPINES	21A	21	14	7B	7B	7B	7B	7B	14	14	14	21
PUERTO RICO	21	14	14	7	7	7	7	14A	21	21A	21A	21A
SOUTH AFRICA	14	14	7	7B	7B	7B	7B	14	21	21	21A	21
U. S. S. R.	7B	7B	7	7	7B	7B	7B	7B	14	14	14	14B
EAST COAST	21	14	7A	7	7	7	7	14	21	21A	21A	21

A—Next higher frequency may be useful this period
B—Difficult current this period

Caveat Emptor?

★ Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

★ Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.

★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

★ We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

★ For $1 extra we can maintain a reply box for you.

★ We cannot check into each advertiser, so Caveat Emptor . . .

GET YOUR "FIRST!" Memorize, study—Command's "Tests-Answers" for FCC First Class License. Plus—"Self-Study Ability Test." Proven. $5.00. Command, Box 26348-S, San Francisco CA 94126.

NOVICE THREE-BAND DOUBLE INVERTED-VEE: Tuned assembled SWR. Under 1.5-1 15-40-80 Novice bands. W3FQJ Design, $15.75. Antenna Products, Box 276, Warrington, PA 18976.

NC-121 RECEIVER with manual, like new, $40.00. Ameco PCL-P preamp, $19.00. Clobe Chief Xmitter, $20.00. M. Severson WØHE, 301 W 17th, Hutchinson, KS 67501.

SCR (GE C50F) 110 Amp. 500 PIV mounted in insulated sub-assembly with 1 N250B, $12. Jon Lusk, 2871 Birch Hollow Dr., Ann Arbor, MI 48104.

RBL-3 VLF RECEIVER 15 to 600 khz, $20; 10B SSB transmitter and VFO, $55; unused Beachmaster 250 watt pa amplifier, $60; Gonset 88-108 mhz car FM receiver, $25; RCA antique AC receiver, $10; TS-155C/UP signal generator, approximately 3 kmc, $8; Finco 6&2 meter beam, $10; $5 each: unused BC-604DM; BC-620A; T39-APQ9, 10 watts on 420; 12 to 1000 volt dynamotors; Central Electronics "A" receiver SSB convertor; Wilcox 308B VHF aircraft receiver; Dynamotors, $2.50 each: 12-250; 6/12-500 volts. Cannot ship all items. SASE for details. Jim Hill W6IVW, 26107 Basswood, Palos Verdes Peninsula, CA 90274.213-378-4411 not evenings.

HIGHLY CORROSION RESISTANT Stainless, Brass, Bronzes, threaded, washer, Hardware for Antennas-Towers, Equipment building. Many Antenna, Guying, Accessories. Lists—Dime! W8BLR, 29716 Briarbank, Southfield, MI 48075.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $2.50 postpaid. Elliot Buchanan & Associates, Inc., 1067 Mandana Blvd. Oakland, CA 94610.

3 PLASTIC HOLDERS will frame and protect 60 cards, $1.00—or 10 holders $3.00. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, TN 37066.

FOR SALE—SWAN 250 & 117 Power Supply, $350 or best offer. Henry Darrell KØLXU, 2506 64th, Kansas, KS.

WRL's USED GEAR has trial-terms-guarantee! 75S1—$299.95; G50—$159.95; SR150—$299.95; HW-12—$89.95; Swan 250—$279.95; DuoBander 84—$119.95; NC200—$249.95; SB34—$299.95; Valiant—$149.95; Ranger—$99.95; Galaxy 300—$139.95; Galaxy Vmk2—$299.95; many more. Free "blue-book" list from WRL, Box 919, Council Bluffs, IA 51501.

NEMS-CLARKE RECEIVERS WANTED. 1400 Series crystal controlled telemetry models covering 215-245/260 MHz preferred but all models in 1300, 1400, 1500, 1600 and higher numbered series also of interest. Please send accurate description of what you have to TUCKER ELECTRONICS CO., POB 1050, Garland, TX 75040.

TWOer, UNMODIFIED, CLEAN, Mike Rocks, Accessories, $35.00. BC-639-A, RA-42-A, Excellent, $50.00. Send for list Surplus, Commercial Material. W6KEC, 320-A S. 2nd Ave., Arcadia, CA 91006.

IBM COMPONENT BOARDS, 3 x 5 in., 6 for $1.00. Cash or M.O. only, include 50¢ postage. Terry Kepner, Box 17038, Tucson, AZ 85710.

CHEYENNE, COMANCHE, AC SUPPLY, $100.00; Vancouver Radio Lab. General Coverage Receiver, $50.00; J. Custy, 4011 Royal Ave., Montreal 261, Canada.

SAROC NEW QTH Stardust Hotel new QTR February 4-8, 1970. Cocktail parties hosted by Ham Radio Magazine, SWAN and GALAXY. Additional information and Stardust Hotel special SAROC room rate card QSP SASE SAROC, Box 73, Boulder City, NV 89005.

WANTED: MINT 80-10 linear, HW32, Heath 3" scope, Ameco pt preamp. Sell: 90 ft. heavy duty tower. Give full particulars, K3WI4, Waymart, PA 18472.

"TOWER HEADQUARTERS!" 11 brands! Heights aluminum 35% off! Strato crank-ups, low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog—$.20 postage. Brownville Sales Co., Stanley, WI 54768.

OPPORTUNITY for Linear Integrated Circuit Design Engineer, San Francisco Peninsula. BSEE, recent monolithic design experience required. Send resume to: Box 921, Cupertino, CA 95014.

ROCHESTER, N. Y. is again Hamfest, VHF meet and flea market headquarters for largest event in northeast, May 16, 1970. Write WNY Hamfest, Box 1388, Rochester, NY 14603.

TEST EQUIPMENT: HP 524 D counter, $495; HP 400 DR VTVM, $45; Dumont 401 BR, $150; Tektronix RM 15, $400. All equipment in excellent condition. D. G. Wilson W6GOT, 2036 Briarwood, Santa Maria, CA 93454. Phone 805-925-0754.

TECHNICIAN: Fast growing cable television company needs electronic technicians in several areas. If you are young, outdoors type, and have experience in trouble shooting and repair of transistorized amplifiers, send complete resume or call Aurovideo Inc., 1380 Main Street, Waltham, MA 02154 (617-891-6748).

73 IS AVAILABLE to the blind and physically handicapped on magnetic tape from: SCIENCE FOR THE BLIND, 221 Rock Hill Road, Bala Cynwyd, PA 19004.

DIAL PLATES: all types. Give your home brew and other gear an attractive appearance. Send for catalogue. Radio Dials, 1397 Washington Circle, Forestville, OH 45230.

COLOR ORGAN KIT: 3 Channel, 600 Watt, $7.50. Cabinet, $8.50. Power Supplies, $2.75 to $8.50. Ceramic Capacitors, $.10. Dual Flasher 1000 Watt, $3.98. Catalog. Murphy, 204 Roslyn Ave., Carle Place, NY 11514.

QSL CARDS—FCC LABELS, eyeball cards—call sign decals, free samples, florescent and glossy. Latest designs. April Products, 56290 Van Dyke, Washington, MI.

WIRELESS SHOP—new and reconditioned equipment. Write, call or stop for free estimate. 1305 Tennessee St., Vallejo, CA 94590 (707-643-2797).

AEROMATIC TOWER, 85', four legs; 35' masting; gin pole; prop pitch rotor. Antennas: Mosley S402 and TA36; Telrex 11 el. 6M; Ranger II; HX30; T/R switch. Will ship. Joe Engressia, 9050 SW 117 Avenue, Miami FL 33156.

TR-108, factory aligned, warranty, $100. Viking 500 transmitter, $200. DX-60, $39. Matching HG-10 VFO, $18. Knight V-44 VFO, $15. SX-101 mkIII, just had factory $45 overhaul (Aug. '69), immaculate condition, works like new! $120. Jim McClure WA9BYR, 627 Dundee Ave., Barrington, IL 60010.

GREENE . . center dipole insulator with . . or . . without balun . . see September 73, page 41.

TELETYPE PICTURES FOR SALE. 50 pics for $1.00. Perforated and audio tapes available. Write for prices specifying speed and tracks. Pictures to be included in second volume solicited. W9DGV, 2210 30th St., Rock Island, IL 61201.

FOR SALE: Drake TR-6, all accessories complete package $750.00 plus shipping. Consider SB-110-A and Swan 250C. J. Gysan W1VYB, 53 Lothrop St., Beverly, MA 01915.

MANUALS—TS-323/UR TS-173/UR, R-274/FRR, TS-186D/UP, BC-638A, LM-18, $5.00 each; OS-8C/U, USM-26, $6.50 each. Hundreds more. List 20¢. S. Consalvo, 4905 Roanne Drive, Washington, DC 20021.

HW-22 $70, Mobile supply, $30, Nixie readout digital volt-ohm meter, $60, Solid state 80 and 40 meter CW xmtr with vfo 30 watts input attractive cabinet, $70, Heathkit VTVM, $25, Hallicrafters TO-9 keyer, $40, Heathkit lab rf generator, $30, Roberts 6000s stereo portable tape recorder, mic, ac supply, $250. K7AZB, Box 252, Mountain View, CA 94040.

FOR SALE: H-P 524B counter HP416A. Wanted—one model SBE side-band exciter for technical material corporation transmitter model 6PT 750. I am interested in swapping test equipment (Tektronix H-P, etc.) for it. Eugene H. LeGer, 63 Jewett Lane, Hollis, NH. 603-465-7791 or in MA, 617-433-2721.

COMPLETE STATION—SWAN 400, 80-10 VFO, power supply and mike. All mint condition. All for $325.00. E. Parks, 6486 Nancy St., Los Angeles, CA 90045.

SELL NCX-3 good condition without power supply, $165. Call 215-692-7547 or write 518 Nottingham Drive, West Chester, PA 19380. W3CAW.

Printed Circuit Resist the Easy Way

When caught one Saturday evening with an all important pc board to make and no resist in the house, I started looking for a readily available substitute. Within minutes I located two things around the house which worked so well I have given up the commercial types.

My system involves laying out the desired circuit to scale on plain paper. After double and triple checking, I tape it to the pc board and mark all the holes with a center punch. The paper is then removed and the lines drawn in with a pencil, using the punch marks as a guide. The next step is to draw the lines again, this time using fingernail polish. When large areas are to be covered, rubber cement works somewhat better because it flows more evenly, but it is often difficult to see what portions have been done. After the polish is completley dry, the lines are "manicured" with a sharp scribe to make them look better and to remove any possible shorts due to the various adjacent areas having flowed together.

The etching process is the same as usual in every way. After the etchant has been flushed from the board, remove the nail-polish with nailpolish remover or Acetone, and the rubber cement by rubbing. The board is then cleaned with household cleanser to remove the residual resist and oxides. Drill the holes, plug in parts, solder the leads, turn on the power and your project is complete. I find this system faster and cheaper than any others I have tried.

William P. Turner, WAØABI

Transmitter Spotting Switch

There are no doubt many ways of keying the oscillator of a transmitter for spotting your own frequency when tuning up to another station or net. Shown here

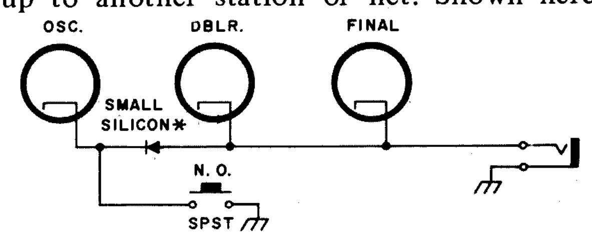


Fig. 1.

are two ways we have gone about it here at this Qth; we are currently using the one with the diode between the cathode of the oscillator and the cathodes of the following stages as in Fig. 1.

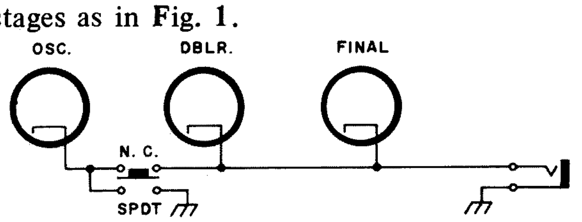


Fig. 2.

The other method is to use a SPDT push button switch in the same place, as in Fig. 2.

Irvin Kanode WA9CKP

CLUB SECRETARIES NOTE

Your club can round up some extra funds by imploring, cajoling, convincing or forcing your members to subscribe to 73 Magazine. Never mind the cries of anguish, just remember that you are doing what is best for them—and the club.

Subscriptions to 73 are normally $6 per year. The special club rate is exactly the same: $6. The only difference is that the club treasury holds 25% of the loot and sends the rest to 73. Send us $4.50 for each one year subscription, in groups of at least five subs. Just think, if your club has 10,000 members you can quickly get $15,000 for the club on this deal!

Send the subscriptions to us on 3" x 5" cards, giving the name, call, address, city, state and zip code of each subscriber. If the subscription is a renewal please include the address label from a recent 73 wrapper. Indicate all renewal subscriptions so we won't start a second sub. We have been known to do that.

Send to Club Finagle, 73 Magazine Peterborough, N. H. 03458

WORLD'S LARGEST INDEPENDENT HAM MAGAZINE

AMATEUR RADIO 73

December 1969
75¢

1969 INDEX
Buyer's Guide
of Ham Gear
Freq Meter, Microwave
Checker, Diode
TV Report, Slow Scan
P.S., Mobile
Christmas, Merry
New Year, Happy

73 Magazine #111, December 1969

Features

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Contents

On the Cover

Commemorating man's first landing on the surface of the moon, this special 73 Christmas cover reminds one not only of the universal quest for peace on earth but also some of the good that has come from modern electronic technology. Early—and recent—amateur radio experimentation and pioneering has contributed vastly to the new pioneering in space exploration. Yet, not surprisingly, many standard switching components used extensively in current ham projects also played a vital role in the Apollo mission in both spacecraft and ground support equipment.

All standard distributor items, the following are shown on the cover from bottom to top (you'll recognize Astatic D-104 microphone at right, we're certain): Oak Manufacturing Co.'s 10-position, 0.300-in. diameter rotary switch (the world's smallest, by the way); at bottom, Oak's one-half inch diameter precision rotary switch; at bottom right, Hart-Advance's microminiature hermetically sealed relay (blue color); in front of pushbutton complex is Hart-Advance's easily recognizable continuous duty general purpose relay; centerstage, Oak's pushbutton switch, four-pole, double-throw per plunger; astronaut is "working" on Oak's ceramic section rotary switch; in far background, Hart-Advance's "VersaPac" miniature industrial relay. Both Hart-Advance and Oak Manufacturing Co. are divisions of Oak Electro/Netics Corp., Crystal Lake, Ill. 60014.

...de W2NSD/1

Wayne Green

SEASON'S GREETINGS from the 73 staff

Here is the whole gang!

In the top row you will see Phil Price, an actor turned production man, who supervises the typesetting, drafting, layout and makeup of all the articles in each issue. Next to him is Lin Green, wife of the publisher, who helps with circulation, though her primary occupation is painting.

In the middle row we see Walter Manek, our resident sculptor, who keeps the 73 Headquarters in repair, helps with the mailing, and several hundred other jobs. Next to Walter is Diane Shaw, our advertising manager. Diane is knocking the advertisers for a loop. Diane writes poetry, rides horseback, and is an all around doll. Dotty Gibson handles our subscriptions and battles our ever efficient computer service down in Massachusettes. Roger Block, to her right, an artist, is our production manager and gets the magazine ready for the printer each month. The November cover was his work. By the "e" is Don Weiss, our circulation manager. Just below Don is Jane Tracey, who sets most of the type for each issue on the IBM Composer.

On the bottom row is Jeanne Caskie, who lays out most of the pages of the magazine and does finished paste-up of the pages and ads. Jeanne has a hobby of painting Cymbolics. . .we'll try and get her to do some on amateur radio. Wayne is next, eager to be operating from Y1, but too overloaded with editorial and publishing work to get away. Whitney Tobias, Wayne's right arm, is on his left (your right). On the right is Joe LaVigne, our bookkeeper, who runs an antique shop in his spare time.

What About Christmas?

Christmas is, for most of us, by far the most outstanding time landmark, measuring off the years even more definitively than birthdays. Coming as it does at the end of the year, it is a time of tidying up things for the year just past. . .a time for remembering, a time for thanking. It is fitting that Christmas is followed quickly by New Year's, a time for looking to the future.

Though it is admittedly a great effort, I shall attempt to refrain from joining the rush to commercialize on Christmas by suggesting, even casually, that you remember your amateur radio friends with a subscription to 73. Restraint such as this does not come naturally to me, you realize. It is even more difficult to exercise this restraint when I recall the pleasure that I felt all through the last year when gift subscriptions to magazines arrived each month. My moral fibre is firm, however, and my convictions resolute; I shall say nothing.

Instead, I would like to suggest that you take a few moments to remember back over this past year and add the names of your particular amateur radio friends to your family Christmas card list. Perhaps you have made some interesting contacts in some of

(continued on page 128)

Leaky Lines

Unfortunately, I must depart from the subject of Amateur Radio at the very start of this, because of a disturbing turn of events. In all this time . . . six months or so, since I have figuratively thrown down my gage in an attempt to challenge the QST editorialist to a dialogue within the pages of both magazines, no one has accused me of anything underhanded or dishonest. No one has taken umbrage at my remarks in a violent way. No one, that is, until now.

I am in receipt of a letter, unsigned of course, which among other things, calls me a left wing radical, communist, socialist, anarchist, pinko, S.O.B., nigger-lover (sic), and God save the mark, a homosexual, although the term used refers to a specific act of sexual deviation, rather than the aberration itself.

As if this weren't enough, I have gotten three phone calls, also anonymous. The first was another choice selection of unflattering appellations, the second was a threat to break both my legs, and the third . . well, the third came at two o'clock this afternoon (Sunday, October 5) and awoke me from my complacency. I am worried about this one, I don't mind telling you. This phone call threatened my wife and little son!

I called the police and telephone company at once, and reported the incident, of course. I have also made sure that my S & W Magnum is always close at hand. I want to assure the screwball who called that if he should be rash and stupid enough to try out his threat, he is likely to learn a lesson that he may not survive long enough to profit from. I will not hesitate to put a slug right into his belly.

I wish to assure everyone that I do not believe in using ad hominem arguments. I do not believe in personal vendettas or below-the-belt kicks. I say this, not because I consider it necessary to issue a position statement to anyone but the over-zealous, super-loyal anonymous foul-mouths who are responsible for this agony into which I and my family have been plunged.

It is cowardly and scurrilous enough to write an anonymous letter, filled with foul, filthy names. But when you make a phone call, threatening the lives of my wife and child . . that is the most unspeakably debased level to which you can sink. I urge that you seek the help of a doctor, whoever you are. You are sick, and your sickness will not only destroy you; it will destroy those whose interests you believe you are furthering. You are doing them about as much good as Jack Ruby did for the Kennedy family . . . none.

* * *

Conceptually, there have always existed differences concerning priorities in the scale of values in Amateur Radio. Traffic people regard rag-chewers with an attitude of rage and intolerance. Rag-chewers loathe and despise contest enthusiasts.

(continued on page 124)

Q. E. D. Quick, Easy, Dependable Transistor Diode Checker

Charles Witkowski W6ICC
7859 Compass Lake Drive
San Diego, CA 92119

The ohm-meter method of checking transistors is not new, and no claim for originality in this category is made with the instrument to be described. What is to be presented is an inexpensive switching device used in conjunction with an ordinary volt ohm-milliameter to quickly measure the more common transistor parameters. We leave the more sophisticated and expensive types of transistor testers (some costing close to $100) to the design engineers and manufacturers.

The schematic shown in **Fig. 1** is straightforward and self explanatory, the entire unit being built into an LMB box chassis 5¼" x 3" x 2 1/8".

Referring to photo **Fig. 2**, starting at the bottom the two insulated tip jacks marked P and N are for connection to the ohm-meter.

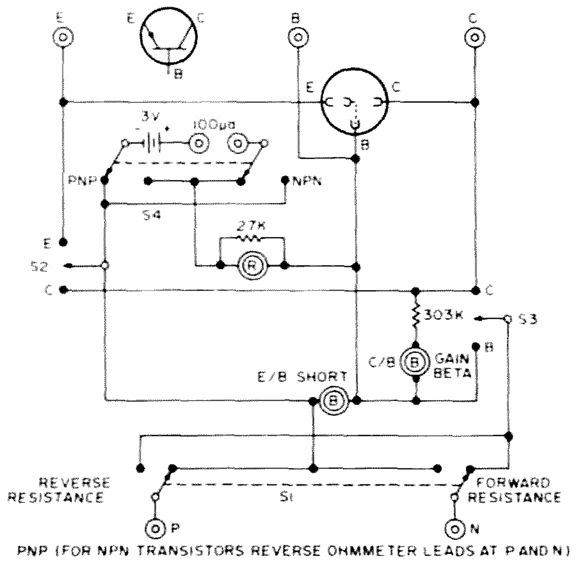


Fig. 1. Complete circuit diagram.

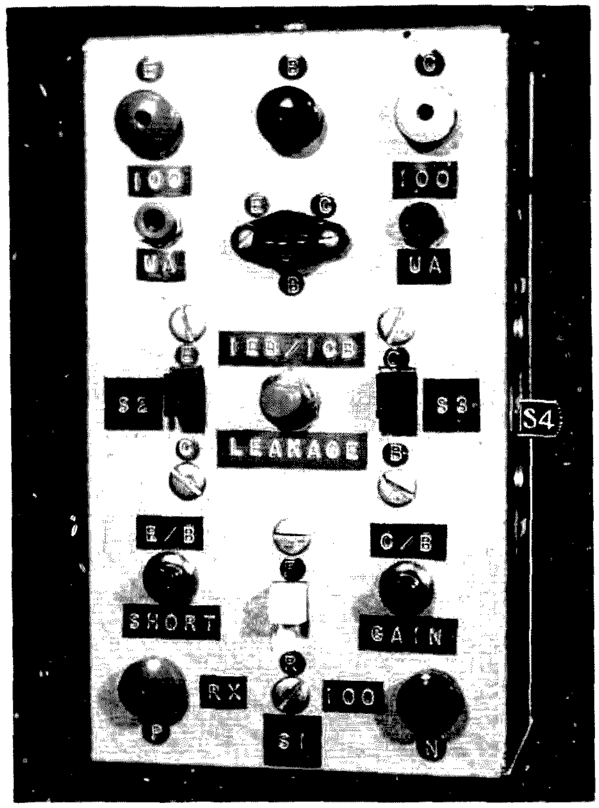


Fig. 2.

Next in the lower center is a DPDT slide switch S1 marked F and R for forward and reverse readings. Next, on the left is a black push button E/B shorting switch. On the right is the C/B gain black push button switch. In the center on the left is a SPDT slide switch marked S2 to connect the P line to either the emitter or collector and marked E and C.

In the center is the IEB/ICB leakage test red push button. This button undepressed allows a protective 27K resistor to be in series with the 3v battery and a 100 microammeter. In the event of an EB or CB short, the meter would show full scale reading or

zero ohms. If so, do *not* depress this button, as you would end up with a blown micro-ammeter. If the reading is in the neighborhood of 50K or plus ohms, then it is safe to depress the leakage button, shorting out the 27K resistor and reading the true leakage current in microamperes.

To the right of leakage push button in center is an SPDT slide switch marked S3 to connect the N line to either the base or the collector and marked B and C. Above the leakage button is the transistor socket, and to either side are the two tip jacks for the 100 microammeter.

On the top row are three insulated tip jacks marked E, B, and C and connected to E, B, and C of the socket. Make three 6" leads with a phone tip on one end and a small alligator clip on the other and color code them to match the color code of the three E, B, and C tip jacks. These will be useful in testing power diodes and power transistors. S4 (mounted on the side of the box) is a DPDT polarity reversing slide switch used in conjunction with the internal 3 volt battery and the 100 microammeter for testing PNP and NPN types respectively, and so marked.

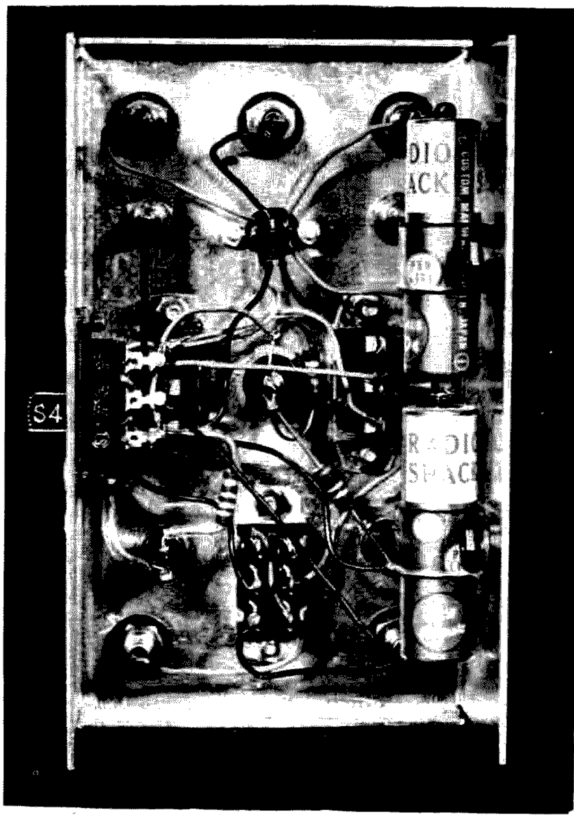


Fig. 3.

Placement of parts is not critical but the symmetrical layout shown in Fig. 2 is desirable for convenient orientation of tests as will be shown later in detailed step by step procedure, not only. for checking but also to identify all leads of unmarked transistors and diodes.

The first thing to determine is the true polarity of the ohmmeter leads. Most ohmmeters, with the exception of the Simpson model 260, have their polarities reversed on ohms. That is, the black or common lead is tied to the positive of the battery and the red lead is tied to the negative side of the battery. A quick check of your ohmmeter can be made as follows. Take any marked diode and measure its resistance. In one position the resistance will be low, and in the reverse position the resistance will be high.

The negative lead of the ohmmeter will be the one that is on the cathode of the diode when it is in the low resistance position. The cathode end of a diode is usually marked with a black band. In any case, it is the lead opposite the arrow in the diode symbol.

The following tabulated tests will be for PNP type transistors only. For NPN transistors, reverse the positive and negative leads at the ohmmeter. The same thing can be accomplished by reversing the position of slide switch SI with a corresponding mental change of the markings F and R for the NPN types. It was found to be less confusing to just change the leads at the ohmmeter and forget the cerebral gymnastics when testing the NPN's.

Most transistor tests will be with the ohmmeter in the R x 100 position. This in. most cases will apply a maximum of 1½ volts to any configuration of the transistor and should not harm it. To get a more accurate reading of the reverse resistance of both junctions, it may be necessary to go to the R x 10K position, but here again take into consideration the voltage rating of the transistor as most ohmmeters employ voltages anywhere from 4½ to 15 volts in the higher resistance positions. A word of warning to the wise!

Now for the tests—

Forward Resistance of Both Junctions. EB-CB

A. Ohmmeter (Rx100 scale) Leads in P and N
B. SI to F
C. S3 to B
D. S2 to E and to C
   High resistance reading=open junction
   Below 500Ω reading=normal transistor

Reverse Resistance of Both Junctions. EB-CB

A. Change Ohmmeter to R x 10K position (See warning paragraph in text.)
B. SI to R
C. S3 to B
D. S2 to E and to C
   1. Low resistance reading denotes a *shorted* or *leaky junction*.
   2. Low or medium power germanium transistors should show a resistance reading of at least 500KΩ (Average about 700K to 1.5 meg.)
   3. Silicon transistors should show *high* resistance readings
   4. Power transistors should show readings of 50K or greater

Current Gain (I ceo)

A. R x 100 Ohmmeter Scale
B. SI to F
C. S2 to E
D. S3 to G
E. Depress rt. black C/B gain button
   1. Meter should show increase in current. (Decrease in resistance reading)

Dynamic Test (Go-No go)

A. SI to R
   S2 to E   High resistance reading
   S3 to C
B. Press E/B short button
   Transistor is O.K. if low resistance reading indicated (less than 500Ω)
C. If only slight resistance change noted on pressing E/B short button, the transistor is defective.

Leakage current—Icbo and Iebo

A. Remove Ohmmeter from P and N
B. S4 to PNP or NPN
C. + 100 μa meter lead to red 100 μa pin jack.
D. - 100 μa meter lead to black 100 μa pin jack.
E. S2 to E → press red leakage button
F. S2 to C → press red leakage button
   1. Low and medium power transistors (10 to 15 μa at room temp 20^{o}c-68^{o}F)
   2. Power transistors—100 μa or more.
   3. Silicon junctions—Fractions of a microampere
   4. Estimate leakage currents at other temperatures by doubling leakage current for each 10^{o} centigrade rise in temperature.

Beta Measurements

A. Remove Ohmmeter leads from P and N
B. S2 to C
C. S3 to C
D. + of 3v battery to emitter
E. - of 2 ma meter to - of 3v battery
F. + of 2 ma meter to collector
G. Press rt. black C/B gain beta button

$$\frac{\text{Beta}}{\text{(D-C)}} = \frac{\text{Ic}}{\text{Ib}} = \frac{1000\mu a}{10\mu a} = 100$$

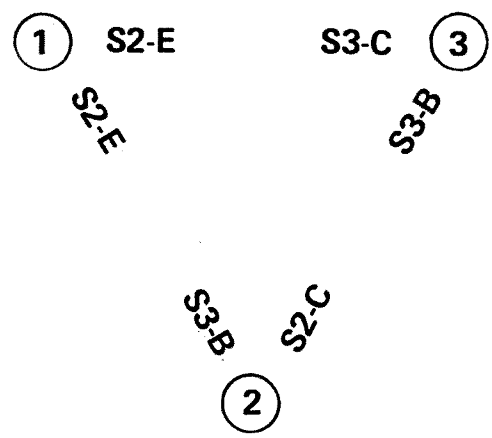
(If meter reads 1 ma or 1000μa)

Beta A-C

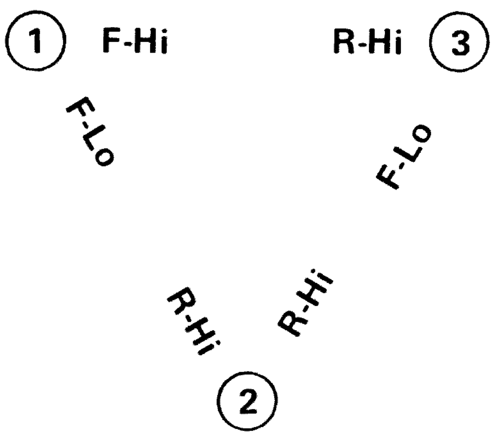
1. Take collector current reading with base open
2. Press C/B gain beta button and note change in Ic current.
3. Change in Ic/10μa = AC Beta

Unmarked Transistor Leads (Base Identification

A. Consider E as (1) unidentified lead
   Consider B as (2) unidentified lead
   and C as (3) unidentified lead
B. Switch set up



C. S1 to F and R



Base is lead *not* involved in the two high resistance readings in the 1-3 position above.

Unmarked Transistor Identification

A. Type PNP or NPN
  1. Low resistance reading when base is negative and positive is connected to either collector or emitter then transistor is a PNP type.
  2. Low resistance reading when base is positive and negative is connected to either collector or emitter then transistor is a NPN type.

B. Collector and Emitter Lead Identification
  1. Take forward and reverse readings between collector and emitter.
  2. The lower resistance reading signifies that the negative terminal of the Ohmmeter is connected to the collector lead of the transistor.

Diodes

A. Ohmmeter (R x 100 scale) to P and N
B. S1 to F
C. S2 to E
D. S3 to C
E. Connect anode to pin jack E
F. Connect cathode to pin jack C
G. Forward reading 500Ω or less (10Ω or less on R x 1 scale)
H. S1 to R
I. Reverse reading–50KΩ or higher

Unmarked Diode–Cathode Identification

A. Ohmmeter (R x 100 scale) to P and N
B. S1 to F
C. S2 to E   E will be +, C will be -
D. S3 to C
E. Connect diode to pin jacks E and C
F. Take resistance reading
G. Reverse diode at pin jacks E and C
H. Take resistance reading
I. With the low resistance the negative lead of the Ohmmeter (Pin jack C) will be connected to the cathode.

Alternate Method–Quick Check of Power Transistors for Leakage and Gain

A. Ohmmeter (R x 1 scale) leads in P and N
B. S1 to F
C. S2 to E
D. S3 to C
E. Connect power transistor to corresponding pin jacks E-B-C
F. Leakage
  1. The lower the Ohmmeter reading the higher the leakage.
  2. Zero indication = transistor shorted.

G. Gain
  1. Shunt B-C pin jack terminals with a 1.5K-½ w resistor
  2. Reading of over 60 ohms = low gain
  3. Reading of between 25 and 39 ohms = medium gain
  4. Reading of between 6 and 12 ohms = high gain

As an exercise to check out the tester, a "surprise" pack of 25 unmarked transistors was purchased from a local radio store for $1.00. Some twenty minutes later, it showed 10 PNP and 6 NPN transistors that were perfectly okay. Nine transistors were defective.

At a little over 6 cents a piece, one can be a little liberal, and in fact a little careless in his use of some of those moderately unsafe experiments and applications. As we said in the beginning, Q. E. D.

. . . W6ICC

W. Edmund Hood W2FEZ
223 Pullman Ave.
Rochester NY 14615

Did Samuel Morse Really Invent The Telegraph?

Long before the birth of Samuel F.B. Morse in 1791, the English were communicating via a system which they called "telegraph." This system, however, had nothing whatever to do with electrical communication. It consisted of a series of high towers with large wooden vanes at the top. The vanes were moved by a cable and pulley arrangement, sending a semaphore message. A system was set up in this country in 1800 to advise Boston merchants of incoming ships. It flashed word all the way from Martha's Vineyard.

Even before the semaphore telegraph systems, electrical communication had been possible. It was just that nobody had thought of it. In 1730, for instance, a man named Stephen Gray had carried out the first experiments in conduction, and had sent currents over hundreds of feet of hempen rope. In 1747, Wilbur Watson sent Leyden jar impulses from the rooms of the Royal Society over miles of wire strung on the London rooftops. Both of these men could have used their set-ups to send some sort of elementary message — — *if* they had thought of it.

It was not until 1753 that anything even vaguely resembling the idea of a telegraph was so much as suggested. The credit goes to an unknown magazine reader who suggested to the editor that messages could be sent from one location to another by means of as many *pairs* of wire as there are letters in the alphabet! A system using 24 wires was installed at Geneva in 1774. It was quite expensive, each wire being buried in a separate glass tube, and the signals were Leyden jar discharges, not sustained currents.

A system was set up and operated in 1812, which used 35 separate circuits, and detected the signals by producing hydrogen and oxygen bubbles in jars of water, one for each circuit (and *we* think 5 wpm is slow!). Operating systems were set up in England and on the continent in the 1830's, but while they did work, they were still very complicated. Giving credit where it is due, the Russians had Baron Schilling who made a workable system in 1825, but the Czar thought the idea of people communicating from one end of the land to another was subversive! He forbade any mention of it by the press.

At long last Morse was to enter the picture. He was born in 1791 in what is now one of the poorer sections of Boston, Massachusetts. Frankly, he didn't know a blamed thing about electricity, as some of his earlier sketches reveal. Originally he was an artist, and a good one at that. In 1817, for example he was able to pull down as much as $240 a week. Even at today's prices, that ain't hay. For a time he was the nation's number one artist. He visited the Louvre in 1831-32 and made copies of many great masterpieces which many of his countrymen otherwise might never have seen. The return trip was the great milestone of his life.

He boarded the packet "Sully" to come home, a talented and inspired painter. While enroute, he got into a conversation about the works of such men as Michael Faraday and Joseph Henry. Then the bug bit him. The voyage lasted a month, during which time he occupied himself making rough drawings of a daring idea. While the sketches clearly showed his ignorance of electricity, the principle was well illustrated. "When you hear of the magnetic telegraph," he said to the captain, "remember that it was invented on the Sully."

As soon as he got home, Morse started work. His ignorance of electricity was playing against him, however, the darned thing just would not work. For three long years he swallowed one disappointment after another. In the meantime his wife died and he was left with three children to care for. He had to turn back to painting. In 1835 he was made a professor at the new University of the City of New York. It didn't pay

much, but it helped keep him and his children from starving. At last he could get back to his inventing.

Try as he might, however, it just would not work. He wound magnet after magnet, but somehow they didn't magnetize. It was pathetic. Morse had a friend named Leonard Galė who had read some of Joseph Henry's work. Gale looked over Morse's apparatus and then told him what was wrong. We shouldn't be too hard on Sam. After all, he was an artist, not an electrician. Nobody had told him the wire used for a magnet had to be *insulated*! Morse tried again, and this time the results were encouraging.

Morse's set-up was much simpler than any others which had been tried in Europe, but still it was unnecessarily complicated. There was no key such as we use. The circuit was made and broken by a series of metal slugs notched in the proper places and inserted into a machine which moved them past a metal finger. As the finger passed over the high areas of the slugs, the circuit was made and broken sending a pulsed code down the wire. The code which Morse first used was too complex to be read by ear. It was automatically traced on a moving paper tape by a stylus operated by an electromagnet.

Batteries in those days were nothing to brag about, and Morse's using a single battery didn't help his system any. Still, with Gale's help he did manage to get over 20 feet, then a hundred, and finally a thousand feet. Beyond that, the resistance of the wire was too much. In 1837 he was demonstrating his apparatus at New York University when he attracted the attention of a wealthy businessman, Stephen Vail. Vail offered to subsidize Morse with $2000 and lab space, provided Morse would let his son Alfred become his assistant. Morse agreed, making one of the luckier decisions of his lifetime. Alfred Vail proved to be a hard worker and a good thinker. Over the next few years he ironed some of the bugs out of Morse's code, got rid of the composing stick with its metal slugs, and greatly simplified the system to a practical and compact set-up. He invented a telegraph printer which he patented in Morse's name.

Long before, in the early 1800's a thirty thousand dollar prize had been offered by the government for any one who could come up with a practical telegraph system for the east coast. Morse got wind of that and appealed to congress. One congressman, Francis O. J. Smith was so taken by Morse's ideas that he resigned from congress to become Morse's "partner." Smith was to later prove to be a crook. An economic panic in 1837 put an end, at least for a while, to Morse's hopes for a federal grant. Morse, on Smith's advice, went to Europe to secure patent rights. He failed, since a couple of other telegraph systems had been long since working. They were, however, far more complicated than Morse's.

After his return, Morse called on Joseph Henry, inventor of the electromagnet, for help. Now Henry was quite capable of making a telegraph system. He just wasn't interested in doing it himself. Years before he had proposed a telegraph system that would have worked by ringing bells. (What a racket!) He took a liking to Morse and consented to help him. Very carefully and diplomatically he pointed out some of Morse's more glaring mistakes and showed Morse his newest invention, the relay. Morse had the brains to take Henry's advice.

Morse's crooked partner, Smith, managed to get a request for federal funds into congress by 1843. It was the last day of that session, and the congressmen were having a ball making corny jokes about the idea of using magnetism, which in that day was looked upon about the same way we look upon E.S.P. Bitterly disappointed, Morse went home. Next day, the daughter of the Commissioner of Patents brought Morse some badly needed good news. His grant had by some miracle been approved. Delighted, Morse promised her the privilege of being the line's first customer. It was she who composed the now immortal message, "What hath God wrought?"

The grant, for a sum of $30,000, called for a test line to be strung from Washington to Baltimore, a distance of 40 miles. Smith awarded the contract to himself, and charged $20,000 for the first few miles. The line itself was a coax type of an affair. After Smith got his money, Morse found out that Smith had not spent good money on such stupid things as insulation.

The contractor, Ezra Cornell, suggested stringing the wires overhead. Morse turned to his old friend, Henry, who seconded the suggestion. The wire was strung, using broken bottles as insulators, from posts and trees. It was completed just as the Whig convention was starting in Baltimore. Morse and his assistant, Vail, tested out the line by sending the news of Henry Clay's nomination. Politicians arriving by express were as-

tounded to discover that the news had gotten there ahead of them. Morse was asked to move his gear into the Supreme Court room of the Capitol. A large crowd gathered there to witness a delightful qso between Washington and Baltimore. Morse had it made.

From there, the telegraph took a one-way trip – up. Newspapers were quick to catch on, and the Associated Press was organized with its own wires. Thanks to a clever public-relations man, telegraph wires were strung as fast as poles could be set up and wire run. The rest is still happening.

The original question was, "Did Morse really invent the telegraph?" The answer depends on how you define the word invent. Now, Morse certainly did not conceive and build every little detail himself. Although he was to later deny the help of Henry and his friends in order to protect his patent rights against outside parties, their contributions are today well known, and all of them shared in the material rewards. Morse was the driving power behind an idea which, while others may have also conceived it, was still the product of his own imagination, and in spite of tremendous obstacles, Morse had the guts to push it through.

. . . W2FEZ

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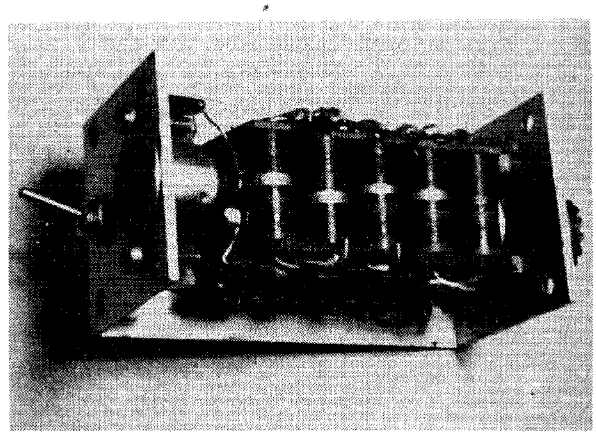
Combination Dummy Load/Attenuator Network

A simple, inexpensive unit is described for use between a transmitter—used as an exciter—and a linear amplifier which will both allow proper tune-up of the exciter alone and reduce the power drive level, as desired, to the linear amplifier.

There are many instances when it is desired to use an existing transmitter as an exciter unit for a high-power linear amplifier. Many such linear amplifiers require a drive level that is only a fraction of the transmitter's output. To some degree, the transmitter can be detuned in order to reduce its output level, but this procedure is rarely possible when several orders of magnitude reduction in the power level are necessary. In such a case one can either internally modify the transmitter for a lower output level or use an alternator network between the transmitter and linear amplifier. In the latter case, the transmitter can be operated at its normal power input level and with its tuning controls at their normal settings.

The unit described in this article functions as both an *rf* attenuator and as a dummy load. The latter capability allows a transmitter to be properly tuned alone for correct operation before it is used to drive a linear amplifier. An optional wattmeter circuit is included which when calibrated allows direct reading, in watts, of the full transmitter output or of the drive level supplied to the linear amplifier.



A simple method of construction is employed. Based mainly on "sandwiching" the resistors used between two pieces of vectorboard. Details are given in the text. SO-239 is used as coax input connector. The circuit function switch is located below the output connector.

Power Reduction	Resistor Factors a	b
1/4 (6db)	.3	1.3
1/5 (7db)	.4	1.1
1/10 (10db)	.5	.7
1/20 (13db)	.6	.5

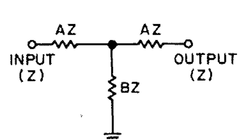


Fig. 1. Approximate resistor factors for "T" network attenuators over the ranges normally desired for exciter power output reduction.

The unit described was built for use with a nominal 100 output transmitter used primarily for SSB service. The construction used, however, can be extended to other power levels for transmitters operating on 80-10 meters. Also, using the information

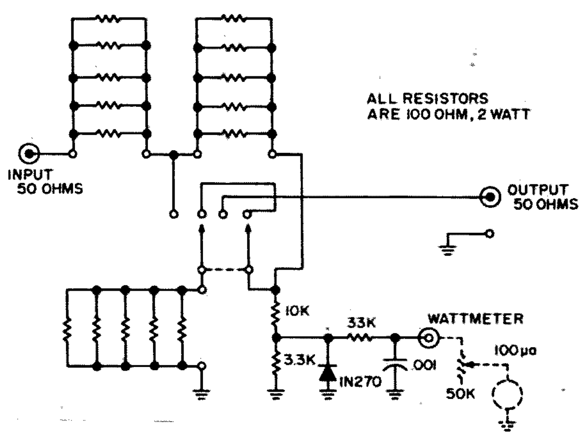


Fig. 2. Circuit of one possible dummy load/attenuator network providing about 10db power reduction. Optional wattmeter circuit is also included.

supplied, the same type of attenuator/dummy load can be designed for other than 50 ohm transmission line systems. The attenuator was not designed as a precision network in order to allow the use of inexpensive resistors. However, the attenuation characteristics are quite satisfactory for the intended usage.

Besides its application as a power reducer when driving a linear amplifier, the unit can be used with a transmitter whenever a quick, known level of power output reduction is needed for operating purposes, approximate gain measurements, etc.

Circuit

Fig. 1 shows the circuit values for a generalized T network attenuator that can be used in any impedance unbalanced transmission line. The scaling factors are only shown for those power reduction levels most likely to be needed when driving a linear amplifier with a 75-200 watt transmitter, in order to avoid unnecessary detail. Factors for intermediate power reduction values can be found by interpolation to a satisfactory degree or one can consult an electronics handbook. The basis of the attenuator/dummy load network is to find the combination of resistor arms that will provide the desired attenuation and still be able to be connected together to form a dummy load of the correct value. **Fig. 2** shows one possible combination. Each resistor bank has a value of about 20 ohms (5 resistors of 100 ohms each in parallel). In one position of the DPDT switch, the resistor banks are formed into a "T" network attenuator. In the other switch position, all three banks are placed in series as a dummy load connected across the input only. The resistance values which result are not exactly those shown in **Fig. 1** for a 10db alternator. However, they are close enough to be effective and some tailoring of the individual legs is possible since each of the resistor bank values vary by a few ohms due to the tolerance of the resistors used. An optional voltmeter circuit is also shown in **Fig. 2** connected to one pole of the DPDT switch. It can be used as a relative power output indicator or if calibrated, as described later, actually measure the power output of the transmitter and of the attenuator.

Many variations of the basic idea are possible. **Fig. 3** shows the use of four banks of 100 ohm resistors. All four are used to form an attenuator that comes reasonably close to the values required for 7db attenuation in a 50 ohm system. Only three are used in series for the dummy load function. In this case only a simple SPST switch is necessary to disconnect the output. The same *rf* voltmeter circuit as used in **Fig. 2** may be added if desired. The switch, in fact, could be eliminated entirely if one were willing to disconnect the output termination in order to use the dummy load feature.

Whatever combination of resistance banks are used in order to achieve a desired attenuation value and the correct dummy load resistance, care must be taken that each resistance bank has sufficient power dissipation capability. The dissipation in each leg of the "T" network varies according to the attenuation level and can be calculated by Ohms Law. In general, a continuous power rating for a resistor bank equal to about

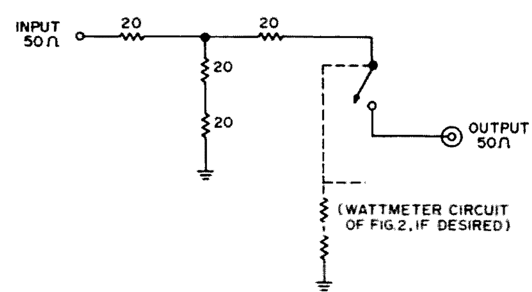


Fig. 3. Another dummy load/attenuator configuration possible with the 100 ohm resistor banks. It provides about a 1/5 power reduction (7db) when used as an attenuator.

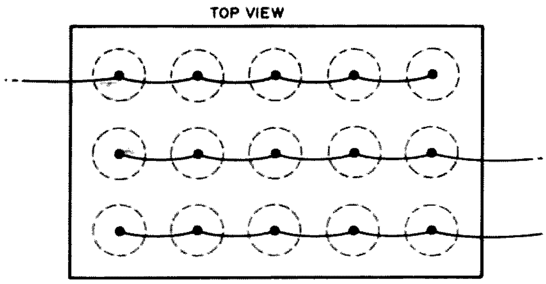


Fig. 4. Similar resistor banks are connected together on the underside of the assembly.

one-third of the SSB peak power rating seems to suffice, including for quick tune-up on CW. For keyed CW service, the power rating should be increased to at least one-half the key-down power level.

Construction

The approach of using a relatively large number of 2 watt composition resistors is far less expensive than using specific value *rf* non-inductive resistors of 10-30 watts power rating. In quantities of more than 10, IRC type RC-2, 2 watt, 10% tolerance resistors cost about 9 cents each. So, one can achieve a 40 watt unit for less than $2 resistor cost. Banks composed of these resistors work well up to 30 mc as long as the interconnecting leads are kept short.

The photograph shows the construction used by the author for the circuit of Fig. 2. Similar construction can be used for larger size units as well. As shown in the photograph, the 15 resistors in rows of 5 each are sandwiched between two 1-1/8" x 1-7/8" pieces of vectorboard. None of the resistors physically touches. The wiring is done using the resistor leads. This construction is somewhat compact to expect full, continuous power dissipation from the unit but suffices for intermittent use. The frame measures 2¾" x 1½" x 1½". A cover is not absolutely necessary since the minor radiation that takes place is not important in this application. If a cover is used, it certainly should be of a perforated type to allow maximum air flow. A SD-239 connector is used at one end of the frame for the input. A dual connector is used at the other end, but normally one would use two RCA type phono jacks–one for the output and one for a meter circuit. The switch is located immediately below the output connector–a miniature Alco MST type.

Calibration

If it is desired to calibrate the voltmeter circuit as a wattmeter, it is necessary to use a probe and VTVM. Using the unit as a dummy load, the *rf* voltage is measured at the input and the power calculated. The 50K ohm potentiometer is used to set the meter at full scale for the highest power level used. The *rf* voltage is measured and the power level calculated in order to calibrate the meter for lesser power levels leaving the potentiometer at its "set" value. The same procedure is followed to calibrate the meter for the output power level by measuring the output *rf* voltage when the unit is used as a "T" attenuator and connected to a regular dummy load. The calibration should be made on the lowest frequency band used and rechecked on the highest frequency band used. If the readings differ significantly on the highest frequency band from those established, it may be necessary to add a few mmf capacitance across the diode in the voltmeter circuit in order to compensate for the slightest reactance present in the circuit.

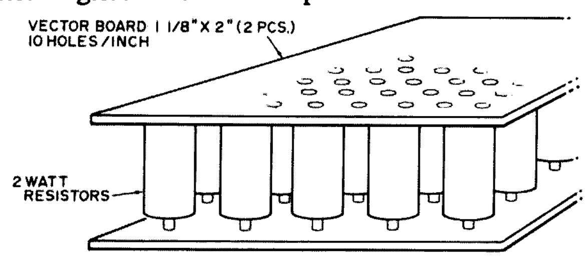


Fig. 5. Sketch showing details of resistor "sandwich" assembly.

Operation

When used between a transmitter and the 50 ohm input of a linear amplifier, the unit is first used as a dummy load for tune-up of the transmitter. The unit is then switched (with the transmitter unkeyed) to its attenuator position. In most cases, no returning of the transmitter should be necessary unless the input of the linear amplifier is particularly reactive.

Summary

The unit described is not intended as a precision attenuator or power measuring device. However, it will perform very well for its intended applications and costs far less than more sophisticated units performing the same functions.

. . . W2EEY

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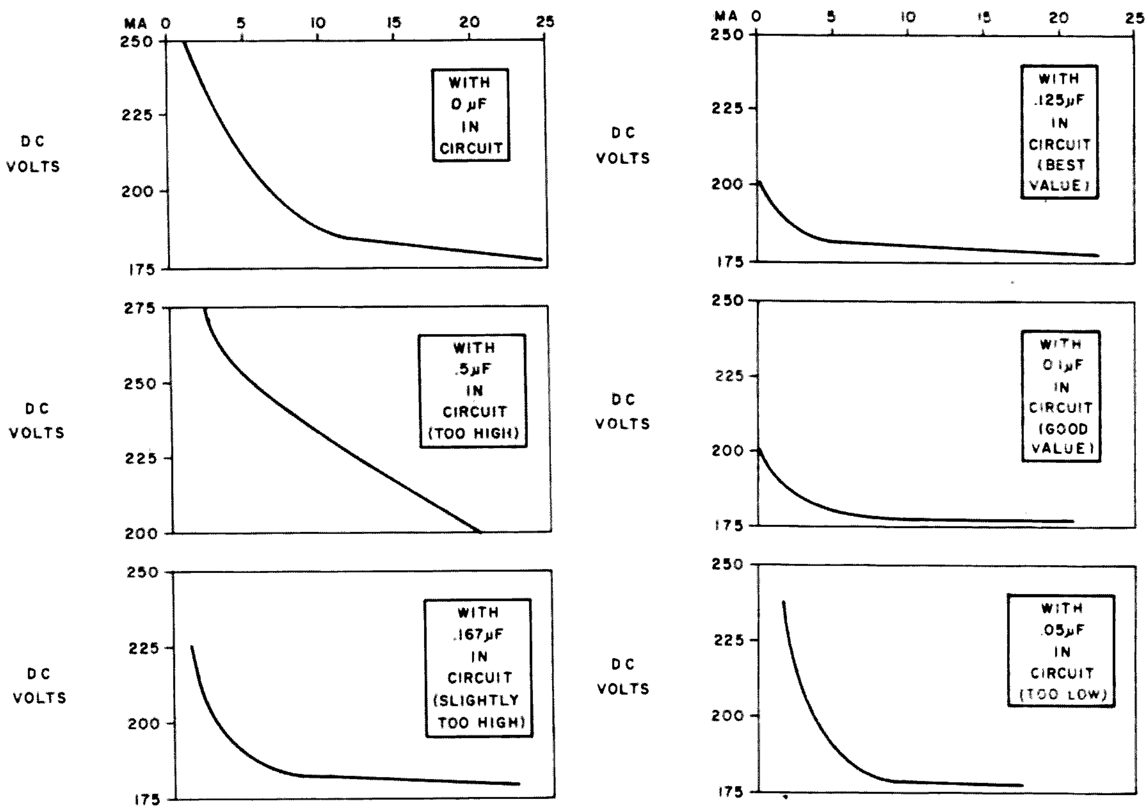
Tuned Filter Chokes – The Easy Way

Amateurs and experimenters who "roll their own" often find themselves in a bind when it comes to designing power supplies which use a choke input filter. At low current, the power supply voltage will soar, unless a substantial amount of power is "bled" off through the customary bleeder resistor. An article in 73[1] went into detail with respect to a way out of this dilemma. For the benefit of those who missed this fine article by K6ZGQ, we might recapitulate his thesis that by tuning the input filter choke, a much higher impedance to 120 cycle ripple is obtained. Not only does this give a lower ac ripple to the dc output voltage, but it greatly improves the regulation of the power supply. Somewhat in the same vein, a shorter article by W6HPH described the means he utilized (an oscilloscope) to obtain basically the same objectives.[2]

I have discussed these methods with other amateurs, but the idea hasn't caught on to



NOTE: THE CURVES ABOVE DO NOT REFER TO ANY CHOKE OTHER THAN THE 8H CHOKE CITED......THEY ARE ILLUSTRATIVE ONLY.

NOTE: ANY CAPACITY VALUE BETWEEN .05μF AND .167μF RESULTED IN AN IMPROVEMENT OVER CHOKE INPUT TO THE FILTER.

Fig.1. Graphs illustrating numerous different capacitor values over a range greater than 3:1. Better power regulation is evident.

any great extent. It seems that many hams are not too eager to experiment when a high-voltage power supply is the subject. Some hams do not possess the necessary equipment to run the required curves on the power supply output, showing voltage vs current. And a few may not understand the technique involved. It's a simple thing, and to make matters even easier, I have developed a method which works out very well in the majority of cases. This solution does not involve any complex testing equipment or needless exposure to high voltages.

Most amateurs are familiar with the ordinary 2.5 millihenry *rf* choke. If we shunt this choke with a 50 pf condenser, the resultant circuit will resonate in the neighborhood of 450 khz. In similar fashion, it is possible to shunt a filter choke with a suitable condenser and obtain resonance at a much lower frequency, in our case, 120 cycles. The values would be slightly different for hams where the supply lines furnish 50 cycle ac, and full-wave rectification would result in a ripple frequency of 100 hz.[5]

What values to use for resonance at 120 hz? The ARRL handbook[3] states that the magic number is 1.77, that is the product of L and C should be 1.77 or close to that figure. Example: if you had an 18 henry choke, shunted by a condenser of 0.1 mfd, the resultant product would be 18 x 0.1 or 1.8, very close to the 1.77 figure. It might be well to stress the fact that exact resonance is not required, a broad type of resonance seems to work out very well.

How to determine the inductance of the filter choke? Easy. Measure it on an inductance bridge, if you can do so. We are interested in the inductance at low current, or close to zero current. If the foregoing is not convenient, I have determined a simple formula that works out very well: read the manufacturer's rating for the choke, let's say it is rated at 10 henrys. Multiply this figure by 1.5 or by 2.0, depending upon the quality of the choke. This will be the approximate figure for the real inductance of the choke at low milliamperes. Thus our 10 henry choke, of good quality, would presumably show an inductance of 15 to 20 henries at low current. Assuming an average of 17.5 henries, we can shunt this with a capacitor rated at 0.1 mfd and this will result in a value (L x C) of 1.75, very close to the desired figure of 1.77 – this is not the least bit critical.

In my case, we had a high-quality choke, rated 8 henries at 475 ma. We estimated the low-current inductance to be approximately 1.75 times the rated inductance. This would indicate an inductance of 14 henries at low current. Theory indicates that a shunt capacitance of 0.125 mfd. would give a product of 1.75, close enough to the 1.77 figure. A series of test runs was made at various values of capacity, and the results are presented. Not only do these graphs illustrate the fact that we have obtained improved power-supply regulation, but the curves also show that the capacitor values may vary over a range greater than 3:1 and still effect an improvement over the "straight choke" input. Any good home-brew experimenter can come much closer than that, so the various curves are presented not so much as verification of the results obtained, but mainly to show how very simple the process can be. In our own case, the curves show that the filter capacitor used in shunt with the input choke could be of any value from 0.1 mfd. up to 0.167 mfd. with very little change in performance.

The 400 volt c. t. transformer was used for reasons of safety. The results were then checked on our large power supply, using a 2,000 volt transformer. Whereas our former bleeder current had to be 70 milliamperes at 1000 volts dc (an impossible figure), it is now greatly reduced to a more reasonable figure of 20 milliamperes, an improvement of 3½ to 1. The results are most gratifying: less heat loss, lower strain on the power supply, and more power for the rig.

By this time there must be a few

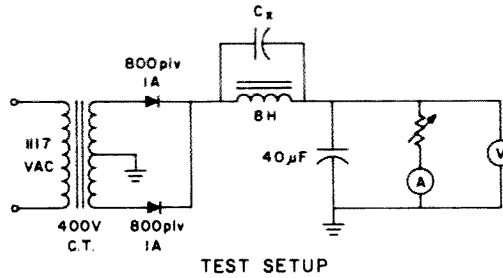


Fig. 2. Power supply test setup utilizing a high-quality choke rated at 8 henries @ 475 ma.

doubters: the method outlined is so simple, how can it possibly work? Perhaps a reference to a well-known amateur publication, the Radio Handbook,[4] may be of help. In the 17th edition, there is shown the schematic and description of a 1 kilowatt power supply, designed for continous commercial service. The input filter choke is rated 6 henries at 700 ma. Ordinarily, this would call for a monstrous bleeder, capable of carrying umpteen mils at 2500 volts. Instead, the designers chose to "tune" the input filter choke, and to reduce the bleeder current by so doing. There is no doubt that these results were obtained in the laboratory after a thorough examination of the problem, and reflect careful engineering. The choke, 6 henries, would have roughly 12 henries true inductance at low ma and the filter capacitor chosen to "tune" the choke was rated at 0.15 mfd. These laboratory results come very close to the mystical figure of 1.77 (12 x 0.15 = 1.80).

Don't forget to use a high quality oil-filled capacitor for this application. The stress on the condenser is high, so make it a point to choose a condenser with a dc rating of at least double the output voltage. It shouldn't be necessary to say the electrolytic condensers are "taboo" for this function, although they may be used in other parts of the same supply. Some builders may find it more convenient to place the choke-and-condenser combination in the negative lead of the power supply. This will simplify the problem of voltage insulation, and the increased filter efficiency will be the same as when the filter choke is wired into the positive leg of the power supply.

. . . W2OLU

References:

1. *Some Thoughts on Designing High-Voltage Power Supplies*, Bob Nelson, 73, November, 1966, p. 30.
2. *Tuned Choke Inputs*, Fred Brown, CQ, October, 1967, p. 80.
3. *ARRL Handbook*, Fortieth Edition, p. 227.
4. *Radio Handbook*, 17th Edition, p. 743.
5. *RSGB Handbook*, Third Edition, p. 438.

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Hey OM – You've Got Carrier There!

In listening to some hams on the air, it appears there is still some confusion about how to tell if you have excessive carrier leakage on an SSB rig. Quite frequently I hear some ham being ribbed about his carrier leakage by listeners close to his QTH, while his signal sounds fine to me.

Before going further, though, let me say there are some unreasonably critical hams on the bands, judging from a purely technical standpoint. This appears to be due, first, to a healthy ignorance of facts and, second, a determination to keep from learning facts different from long-held prejudices.

The particular ham I refer to here, however, is the one that will complain that "you've got carrier there" when the signal is really quite acceptable. This, of course, is a great disservice since such a report can cause needless troubleshooting on a perfectly okay rig. It could also be mentioned that if the listener were adept at tuning his receiver, he would never know the station had carrier, since carrier presence is inaudible in any decent SB rig until the receiver is mistuned by more than twenty to fifty cycles. Evidence that many hams have not mastered SSB tuning is abundant on any net. It is not uncommon to have many hams call in 50 to 100 cycles off frequency. However, a review of certain facts might clarify this "excess carrier" situation and prevent uncertain hams from getting overly excited if some lid gives them a "you've got carrier" report.

First, all rigs have carrier. It is impossible to get rid of carrier completely. Even a very, very good rig will consistently have an actual carrier suppression factor of only about 40 db and this will vary over normal environmental condition changes. If the final CW power output capability of such a rig is 1 KW, the residual carrier is at least 100 milliwatts of *rf*. That's over twice the *rf* power *output* of a CB handi-talky which has a range of many miles if put into a ham antenna. Obviously, persons in the same city or nearby cities will hear "carrier" between words and phrases. The reason is simple. The AGC of most rigs will make all signals from S1 to 40 over S9 about equally loud in the speaker. This is because AGC is derived from the audio instead of *if* signal. The KW rig across town is going to boom in at about 20 over S9. Therefore, his -40 db carrier is going to be about S7, which will create quite a noise in a mistuned SB receiver. (Each S unit is about 6 db.) The solution to the annoyance of such a residual carrier is to learn to tune the receiver. Complaining to the station operator won't help any because, believe me, he isn't about to replace his crystal filters at their high price. The above case is rather obvious, so let's take a more typical case – one with 30 db carrier suppression, which is still not a sloppy rig. Thirty db is far more carrier suppression than is necessary to get all the signal-to-noise improvement which SSB has to offer. Twenty db suppression is all that most SSB filter manufacturers will guarantee, and a balanced mixer can give from 10 db to 30 db more carrier suppression, depending on degree of balance, voltage, temperature and vibration. In commercial gear, balance is not always too stable over environmental extremes. Therefore, it is reasonable to expect carrier suppression to run as low as 30 db on perfectly normal rigs.

Now, a 200 PEP (100 WCW) exciter with 30 db carrier suppression puts out 100

milliwatts of carrier. One hundred MW of CW on most bands will go a long way. In fact, 30 db is only 5 S units less powerful than the 100 watt signal itself. So, if the fellow with a 30 db carrier rejection rig (and there are lots of them) is putting in an S8 signal for instance, his carrier is going to be about S3. Most SSB receivers will give out the same audio level for an S3 signal as they give for any stronger signal, courtesy of their good audio derived AGC systems. Consequently, between phrases the carrier simply has to be there; and if the receiver is off-tune, it will boil through quite noticeably. That adequately makes the point. The solution is not in complaints about "carrier" but in acquiring a little more skill in tuning an SSB receiver.

Now, what if you do have carrier? Well, that's easy enough to tell from your plate meter reading. You don't have to depend upon listener reports exclusively. With an exciter, when you push the talk button and cover the mike with your hand to keep out room sounds, the plate meter (usually the S meter) reads PA idling current. In a normal rig with no audio input, only two things are likely to make this current higher than it should be. These are too little PA grid bias, which is adjustable by pot on almost all exciters, or carrier leakage.

So, a knowledgeable ham glances at his plate ammeter occasionally and notices whether his PA is idling at about the current it should have. If current is high, he will look for bias drift or carrier leakage. But if the plate current is okay, he will take any "carrier" reports with a large grain of salt. For a very unfounded complaint he may even counterattack with a "poor audio fidelity" report to even things up.

If you have a linear it is very simple to tell whether the exciter is putting out excessive carrier. The idling plate current is quite low on most linear amplifiers. For instance, on my linear, a Gonset 201, the idling current is 50 ma. Full 1 KW CW current is 650 ma. Suppose the linear idling current, with exciter in the receive position, is 50 ma and the current rises to 60 ma with the push to talk button on, but with no noise going into the mike. The amount of carrier leakage is defined by this slight idling current increase. The 1 KW output corresponds to roughly 600 ma of plate current increase. Thus, 10 ma of increase is one-sixtieth as much as full output. The plate current of a linear is fairly proportional to power output because linears have pretty good voltage regulation in the plate supply. Therefore, any additional *rf* output takes a proprotional dc current input. The increase in plate current can be used as a handy indicator of power being put out by the linear after it is tuned up.

The carrier leakage in the example given is about one-sixtieth of a full KW output or about sixteen watts, which is not good. Carrier leakage should not be above ten watts with a KW rig even for a 20 db carrier suppression exciter. So, 60 ma on the rig would mean real trouble. In actual practice the plate current changes about 1/2 ma, meaning I have ½/600 of 1 KW or about 1 watt of carrier which is -30 db. This agrees pretty well with a spectrum analyzer reading of 35 db carrier suppression. The manufacturer claims 45 db suppression but that is at one voltage, temperature, and pot setting.

Therefore, we have seen how your plate meter on a linear tells you what carrier is going out. Of course, it is possible if you have just fixed up the rig that the bias has shifted in the linear to cause a higher plate current at idle, but if you concern yourself only with the change in linear amplifier current as the PTT button is pressed, bias drift won't foul you up.

If you have only an exciter, without linear, bias drift can only be distinguished from carrier leakage by pulling out the tube which drives the final amplifier. With the tube out, no carrier can reach the final, so the plate meter must read just the idling current without carrier. Note the reading and replace the tube to see if there is any change in idling current. If so, use the method just given to estimate the fraction of full power leaking through. By this simple technique you can tell whether you have excessive carrier for your rig easily enough, and you won't need to be needled about it by listeners. Listeners may do well also to bear in mind that not everyone has the same quality rig. Ham radio is a hobby, and it shouldn't be made unpleasant by a few immature hams who think perfect carrier rejection or perfect audio fidelity or perfect VSWR is something very desirable. The most desirable goal is *enough* carrier rejection to do the job intended without wasteful over design or needless time wasted achieving the last few percent of perfection. The same goes for VSWR and fidelity; and some of the hams who complain about fidelity and boast of their expensive microphones are really

uninformed. Anyone who tries for high fidelity through a 2 KC SSB *if* filter might also try to build a ladder to reach the moon. I get unsolicited comments on good audio quality using a $1.99 ceramic mike cartridge, simply because even a cheap mike is about as good as a 2 KC receiver *if* is capable of reproducing. The old AM boys who try to get fidelity out of SSB rigs like they used to get out of 10 or 15 KC bandwidths are kidding themselves. That, however, is another story which I'll set a pen to one day soon.

In summary, this discussion has reviewed the facts about real carrier suppression values versus manufacturers' claims; also, ways to judge whether your carrier leakage is excessive were reviewed. It is hoped that frank discussions such as this one will cause those picky hams, who by nature must find a little fault, to realize they are on shaky technical ground when they complain about moderate carrier suppression on a signal. This is especially so if they are not very far from the transmitter involved. Also, the fact that a complaint of carrier leakage automatically means the complainant's receiver is pretty well off frequency will remove the psychological air of superiority involved in such situations, which in itself should go far toward reducing the frequency of occurrence. The unspoken thought that "maybe I can't get my carrier suppressed completely but then you can't tune your receiver either" could go a long way to keep complaints to a minimum unless there is a real need for one.

. . . W4NVK

A HANDY SUGGESTION TO KEEP WIRE NEAT

A simple solution to the problem of reaching for an odd length of wire or test leads and jumpers only to find them tangled up with each other came to mind recently.

The cardboard tubes from toilet tissue rolls are what I use. The pieces of wire are simply coiled and shoved into the tubes which can then be put into a box or drawer without the usual tangled mess that usually results. This method also works well with excess power lead lengths which may be behind the operating desk.

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Bandswitching the Swan-250 and TV-2

I sure was anxious to try out my newly-acquired TV-2 two-meter transmitting/receiving converter. Considering that I had to (1) drive back from York, Pennsylvania, to Washington, D. C., (2) make the necessary modifications to the Swan-250 six-meter SSB rig, (3) take one side off my operating bench which was ¼ inch narrower than the transceiver/power-supply/converter combination, and (4) actually make the necessary connections, I guess I did pretty good in being operational on two meter SSB by 2:00 a. m.

Unfortunately, there isn't much two meter activity (SSB or anything else) at 2:00 a. m. on a Monday. After ascertaining that the gadget was, in fact, receiving 145 to 145.5 mhz and putting out an upper sideband signal in the same range, I said to myself, "Now I'll switch back to six meters and see who's still up." It was then I discovered there are lots of knobs and things on a TV-2 converter, but a switch to get back to six meters isn't one of them! I went to bed, thinking I must have missed something, but a quick look at the TV-2 manual the next morning confirmed that it was not I, but the Swan Company, who had missed something–it is necessary to undo and re-do a couple of coax fittings and some Jones plugs to change bands.

Now maybe some operators are content to spend five minutes changing from two meters to six meters, or vice versa, but K3LNZ isn't one of them, even discounting the difficulty of starting a 12-pin Jones plug with 800 volts on it by Braille only–or the equally disgusting alternative of unplugging the doggone gear and removing logs, pencils, mike, etc. from the operating table so that the equipment could be pulled forward. Accordingly, plans were laid to install the band-switching capability the manufacturer unaccountably left out.

Quite a bit of time was spent discovering that it was impossible to modify only the TV-2. For those who want to know why not, let me point out that the 12-volt dc relay supply will not accomodate any more drain; in fact the TV-2 plus the 250 is too much if the line voltage drops to as much as a volt or two below normal. Were the exciter B+ not routed through 3 separate wires in the cable (7, 9 and 10), 110 volts could be

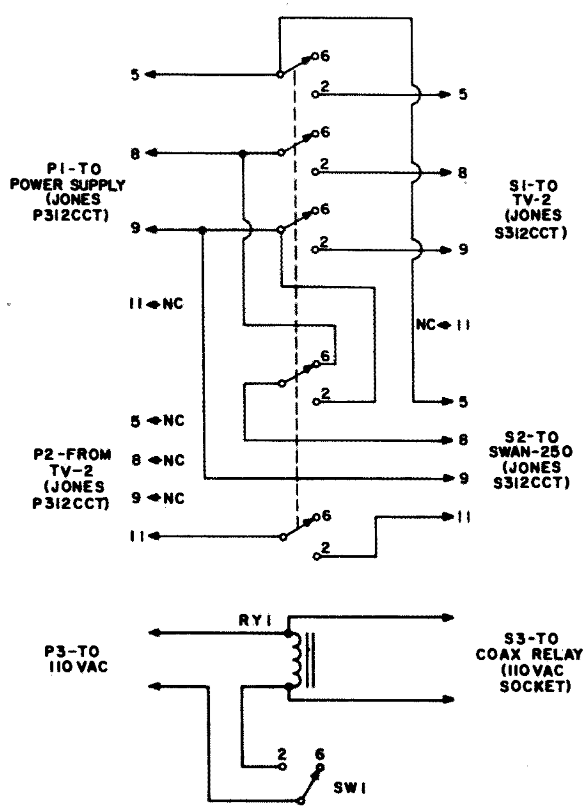

Fig. 1. Wiring diagram.

brought down the cable from the power supply for relay-operating purposes, but this would involve modification of something beside the TV-2.

The final decision to build an outboard unit was based then on three factors (1) retaining interchangeability, (2) somebody else might build such a unit if they knew it wouldn't affect that old bugaboo, "re-sale value," and finally, (3) I could sell the article to 73 more readily.

Actual construction is quite simple, once it is determined that 8 of the 12 wires in the power cables can be ignored in working out a band-switching arrangement. So, get a chassis, a relay with a 110 v ac coil and the contacts to break one connection and complete five when energized, an SPST switch, two each Jones P312CCT plugs and S312CCT sockets, a 110 v ac chassis-mounted receptacle, about five feet of 12-wire cable, some terminal strips, and start building.

First, mount a Jones plug or socket on one end of each of four sections of 12-wire cable. Keep track of which color goes to which pin, and make them all the same, using heavier wires and/or extra wires (if available) on pins 4, 5 and 6 which carry low voltage at relatively high current. Bring the opposite ends of the cable sections through rubber grommets into the chassis. Connect all #1 wires together on the same lug of a terminal strip. Do the same with all #2, 3, 4, 6, 7, 10 and 12 (in other words, all except 5, 8, 9 and 11). Now wire the remaining four wires as per **Fig. 1**,noting that RY1 is energized when switching *to two* meters *from six* meters. Finish off by wiring up SW1 and S3 to provide 110 v ac to the coax relay socket, S3 at the same time RY1 is energized.

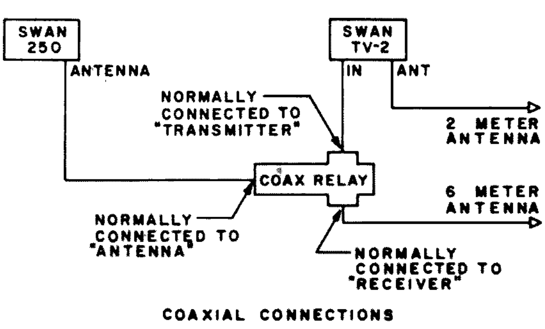

Fig. 2. Coaxial connections.

Remove the normal cabling between the power supply, transceiver and TV-2, and plug in via the adaptor, as shown in **Fig. 1**. A check at this point will show (assuming you were on two meters) normal operation on 2 with SW1 closed, and normal receiving but not transmitting (check this only briefly) with SW1 in the six meter (open) position.

Now connect up that old coaxial relay left over from AM days as per **Fig. 2**, which will route the output of the 250 into the six meter antenna for six meter operation, and into the TV-2 for two meter operation. In addition, a *Dow-Key* or other good relay will short the six meter antenna to ground during two meter operation, preventing six meter signals from over-riding those on two while listening, or stray six meter signals being transmitted while transmitting on two.

Another sore spot, on the 250 (with or without the TV-2), is the necessity to hold a push-to-talk switch while talking. Since I like to throw a switch and have my hands free (such as for logging contests), I made one more small modification which can be made to any 250 in which there is no crystal calibrator. Examination of the schematic will show a contact on SW2 which is grounded in the *calibrate* position. (This is the one that shows a lead going to Pin 7 of the 12BA6 calibrator, but actually is unused when the calibrator has not been installed.) Running one wire from this contact to the "tip" contact on the microphone jack, J3, will result in the 250 going to full transmit when SW2 is thrown to calibrate. Thus, SW2, ptt or vox will put the 250 on the air, as you please.

. . . K3LNZ

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Cheap and Easy Selectivity

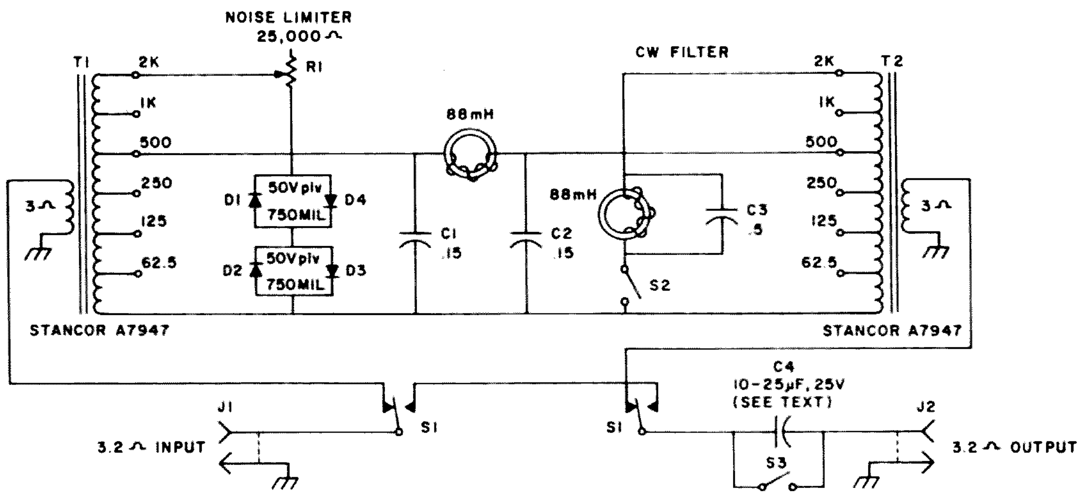

Fig. 1. Circuit for the filter for improved selectivity.

A new receiver was purchased for this QTH about eighteen months ago. It was a big improvement over the much used RME-69 which had served so faithfully over the years. After a few weeks of use, it seemed a little more selectivity would be nice. Not wanting to add an outboard *if* filter or a Q multiplier, an investigation of audio selectivity was begun. This meant digging in all the back issues of radio magazines I could find.

A short article by W6SA1[1] was found along with several other ideas. The result is the filter I am now using with my SX130[2]. The capacitor C4 can be anything from 10-25 mfd depending on your ear. Hallicrafters uses 25 mfd. If you are using a Hallicrafter R48A speaker capacitor, C4 may be omitted as the speaker has one in the 3.2 ohm lead.

The high frequency response cuts off rapidly above 2000 and below 400 hz when C4 is in the circuit. The CW filter peaks sharply at about 1000 hz. **Fig. 1** is the filter I am using. A simpler one is shown in **Fig. 2**

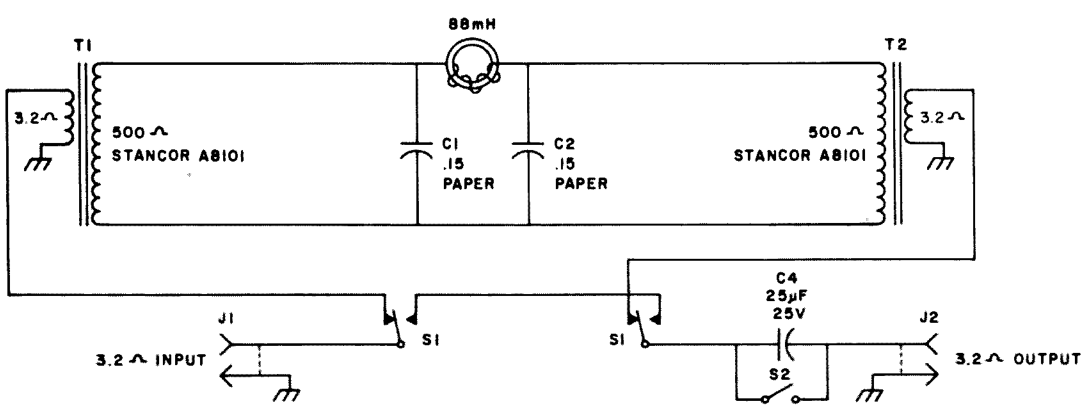

Fig. 2. This filter circuit was also used, and, although simpler in design, produced good results.

which worked very well.

The CW filter won't work so well on 500 ohms as it will at 2000 ohms or above. If the CW filter is included, it is suggested the output transformer is a multitap one from 500 to at least 2000 ohms. The CW filter is connected to the 2000 ohm or higher tap.

Most of the time the filter is left in the speaker circuit, but the noise limiter is seldom used because the filter does such a good job of taking out the sounds outside the middle audio range. A very worthwhile improvement is the 5 x 130 which was noted when the 6BE6 in the product detector was replaced with a 6BY6.

This is about the easiest way I know of to get more selectivity without digging into your receiver or spending the week's grocery money (less than $10). The results in my case were much better than I had ever hoped for; in fact, this little building project was one of my more successful ventures.

. . . W5INU

Notes

1. 73, February, 1965, p.71.
2. 73, June, 1962, p.36. Hallicrafter R48 speaker.

VHF-FM-Part III

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Hand Held Portables

The abundance of portables is one of the strongest points for FM. In time of emergency, you need not be connected with commercial power in any way, thus giving operation in the most extreme conditions. If you have access to a repeater, one unit could be your portable, mobile, and base station. If the repeater is out of commission during the emergency, you had better be able to go "direct" for maximum reliability.

The usual FM portable is quite different from the usual 100 mw 11 meter rig. When a C.B. walkie-talkie weighs, say 16 oz., a common FM portable may weigh over 16 lbs. (yes, lbs.). As for power, FM portables seldom run under one-watt or over five-watts output. The rigs are either in packset form (hand-held unit at waist level with external mike) or if you've got the money, a single hand-held unit like the 27 mhz type. Power is often supplied by Nickel-Cadmium (ni-cad) batteries. The price of the unit itself is brought up with ni-cads over dry batteries, but the savings in buying new batteries overcomes this.

The care of ni-cads is an art in itself. One can easily ruin one of these batteries. Before you even turn the unit on for the first time, you should become very familiar with ni-cads with regards to charging, discharging, and storage. With used ni-cads running up to $15 and new batteries going for around $65, you can't afford to destroy them! You do not have to use ni-cads with many of these rigs, however. You can use Mercury, Alkaline, and the common Carbon-Zinc battery, but they just do not respond to charging and over-all life as well as the ni-cad. With proper care, the ni-cad should last indefinately.

In general about packsets—these can also come with telephone-type hand sets as well as the standard external mike and internal speaker. Also, when planning to purchase any recent vintage portable, you can count on getting one with a narrow-band receiver. With transmitters, you can usually select wide or narrow-band operation by merely adjusting the deviation pot, while receivers will require a fair amount of conversion.

Following are descriptions of just a few of the more popular portables. Since 2 meters is where most FM is, we will discuss high-band gear. In most cases, however, there is a 6 meter rig with fairly similar specs. **MOTOROLA FPTRU-1 AND FHTRU-1:** These are two old "war horses" which are entirely made of modular tube construction. If unconverted, these should be avoided unless you have plenty of time. Due to their age, these are sometimes in poor condition. **MOTOROLA P-33:** Production was stopped around 1965. These have quick heating tubes in the transmitter. Some have a partly transistorized receiver (P-33 AAM) while others have an entirely transistorized receiver (P-33 BAM). Receiver sensitivity is 1μv and 0.35 μv with an FET pre-amp. One side note... to install an FET pre-amp in this unit all you need is a 3N128. You put this FET between two tuned front-end stages already in the unit and that's it. . .no additional components needed! (thanks to W1RYL for this information). Power output is 5 watts with a 2E24 in the final. Power can come from ni-cads, dry batteries, your car's 12 vdc ignition system or other external source. When not running on internal batteries, be sure that the unit is getting exactly 12 vdc the transmitter has three 6397's as the driver (look up the price on one of these some time) and it has been found, the hard way, that these will blow if the power supply is not giving the correct potential. The weight of the unit with ni-cads is 18 lbs. Electrically, the P-33 can compare with a Gonset Communicator I, II, or III as well as other 2 meter transceivers. You can get a P-33 BAM for about $80 less ni-cads and as-is. Ready-to-go units go for around $140. **MOTOROLA H-23:** same as P-33, but one-watt and 12 lbs. with ni-cads. Price : about $65 less ni-cads and as is;

$125 ready-to-go. **MOTOROLA H-23 DEN (DCN) or HT-200**: These rigs are the same units, but the names are different. The HT-200, as it is now called by Motorola, can come with 1.4 or 2 watts, remote speaker and mike, and Private Line (continuous tone squelch). If you wish, the antenna can be built into the mike cable! Receiver sensitivity is 0.5 μv, with the weight of the unit varying between 32 and 38 oz. This unit can also come in a 450 mhz version for use in a "down-link, up-link" repeater set-up. The entire unit is hand-held like a CB rig with the size varying between the size of 3 to 4 packs of cigarettes. Needless to say this unit is in great demand. You might obtain a used unit for about $200. **MOTOROLA PT-200**: This unit is a new breed of P-33's which can come in either 2 or 5 watts. The transistorized unit has a receiver sensitivity of 0.2 μf with an FET. Weight: just 5 lbs. If you can find a source, the price used is about $225. **G.E. VOICE COMMANDER SERIES**: These are quite popular because they are light weight, small and are not as expensive as one might imagine. They weigh roughly 5 lbs., and are about the size of the Handbook. One watt out is about what to expect for power. The Voice Commanders can be used with dry batteries or ni-cads, with ni-cad chargers going for about $10. Receiver sensitivity is about 0.35 μv with a pre-amp. There are three types of Voice Commanders: **VOICE COMMANDER I**: This version has tubes in the final but the rest of the unit is transistorized. The speaker and mike are built into the case so you have to talk right into the unit. The standard supplier will want about $75 for this unit with ni-cads. **VOICE COMMANDER II**: This unit is fully transistorized, but you still have to talk into the rather large case using two hands. The price is about $100. **VOICE COMMANDER III**: This unit is fully transistorized like the above, but it has a provision for an external PTT mike and speaker. The Voice Commander III very often comes with a built in pre-amp. This version is hard to find as surplus. With the new unit going for about $700, $175 is about what to expect used with ni-cads.

. . .WB2AEB

Sunspots And The Ham

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One of the most interesting occurrences on the sun's surface is the appearance and disappearance of dark spots known as sunspots. These dark areas range from 500 to 50,000 miles in diameter, and generally occur in pairs. They appear dark since they are much cooler than the solar surface they hover over (3000° K compared to 6000° K on the surface[1]). The life span of a sunspot can range from several hours to as long as 18 months, but the average life span is about one week. Sunspots occur singly or in groups ranging in number from two to over one hundred. Groups generally have a large leader spot toward the west and nearer the solar equator which generally lasts longer than its companion spots.

The number of sunspots varies from year to year, but generally reaches a peak every eleven years. The average period between minima[2] is eleven years, but cycles have varied from about 8.5 to about 14 years. Sunspot cycles with numbers over one hundred (like the present one) generally have a 10.7 year period between maxima and minima, rise for 3.5 years, and decline for 7.2 years. Lesser number cycles have an 11.08 year period between maxima and minima, rise for 4.94 years, and decline for 6.14 years. The cycles with higher sunspot numbers generally rise more rapidly and decline more slowly than cycles with lower sunspot numbers.

The number of sunspots is determined by the following formula:

$$\text{Number} = k(10g + n)$$

where g is the number of groups observed, n is the number of individual spots observed within the groups. K is a constant determined for each telescope, which gives results in accordance with the calculations of the Zurich Observatory. This formula was developed years ago by Rudolf Wolf of the Zurich Observatory. Before his death in 1893, Wolf had determined the sunspot numbers back to 1749 and the years of maxima and minima back to 1610.

Sunspots have strong magnetic fields. The strength of the magnetic field is related to sunspot size since larger spots have fields of about 3500 gauss [3], and smaller ones have fields of about 100 gauss. The magnetic polarity of the leader spot is almost invariably opposite to that of the follower spots. about 150. Several dips occur in the critical grequency (foF_2) curve after the 150 sunspot number. F_2 reflection is highly dependent upon sunspot number. Both the muf and foF_2 reach their peak at the peak of the 11 year sunspot cycle.

The Sporadic E layer, which is important to ten, six, and two meter operators, is an area of patchy ionization[5] about 50 miles up. The upper frequency limit for E reflection is not known, but Sporadic E skip has occurred as high as 144 mhz. The critical frequency for the E layer can be determined by the following formula:

$$foE = 0.9[(180 + 1.44\ R) \cos x]^{0.25}$$

where R is the Zurich sunspot number. The exponent varies slightly, but 0.25 is a good value for amateur use. X is the solar zenith angle[6]. This formula will give results within 0.2 mhz of the observed frequencies.[7] The Sporadic E layer, like the F_2 layer, has its muf peak and foE peak at the peak of the eleven year sunspot cycle.

The eleven year sunspot cycle is very important to every amateur radio operator because of the way if influences propaga-

It is interesting to note that leader spots in the northern solar hemisphere usually have opposite polarity to southern hemisphere leader spots. Many exceptions occur to these magnetic properties, but the information is based on statistical results with a high verification probability.

Sunspots have a profound effect on propagation in the amateur bands. The atmospheric layers which play predominant roles in amateur communications are the F_2 and Sporadic E layers. Most contacts on the bands below 28 mhz are the result of F_2 layer reflection. Sporadic E layer reflection is important for 28 mhz short skip (up to about 2500 miles with multi-hop), skip on 50 mhz (distances comparable to those on ten meters), and occasional long distance openings on the 144 mhz band.

The F_2 layer, which is about 200 miles up, is influenced by solar activity. The highest frequencies are reflected at the peak of the sunspot cycle (50 mhz is often reached). Depending upon solar activity, the muf (maximum usable frequency for reflection) can go as high as 60 mhz or rarely reach 28 mhz. The critical frequency[4] rises in direct relation to sunspot number up to tion. At the peak of the cycle 80 and 40 meters can be nearly useless, but the higher frequencies (20 to 10, occasionally 6 and 2 meters) reach their DX peaks. At sunspot minimum the reverse can be true—80 and 40 become useful and the higher frequencies are useless. With a basic knowledge of sunspots and their effects upon propagation, the ham can choose the correct band for DXing or local work on any day.

. . . . WB2VFX

Notes

1. K^o are degrees on the Kelvin scale of absolute temperature on which 0^o is equal to -459.4^o Fahrenheit.
2. Minima refers to minimum points, maxima refers to maximum points.
3. The gauss is the unit of magnetic induction.
4. Critical frequency refers to the frequency at which vertically transmitted signals fail to reflect back to the point of transmission.
5. Ionization is the process of removing electrons from atoms by the action of solar radiation.
6. Solar zenith angle is the angle formed by the sun's rays and a line perpendicular to the ground.
7. The formula gives the critical frequency for the E layer. The muf and critical frequency for Sporadic E (foE_s) can be much higher than the observed values for the E layer.

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SSTV

A Taped Lecture delivered at the Congrés International de Télévision d'Amateur, Armentières, France, 1969.

Gentlemen, greetings from Sweden.

I am very pleased to have the opportunity to inform the participants of the international amateur television congress at Armentieres about the slow-scan television activity in Sweden and slow-scan TV in general.

We are today four amateurs in this country who have complete slow-scan TV equipment, namely SM3BCV, SM5CMM, SM5DAJ, and myself.

The possibility of being able also to see the fellow at the other end has certainly caught the imagination of many amateurs, and the longer the distance that can be covered the more exciting it is.

I became interested in SSTV in the end of 1967 and soon got a monitor working. After some weekends of patient listening I succeeded to monitor and record on tape transmissions on the American SSTV-net on 20 meters. That did it, and now I became really fascinated and started to build my first slow-scan camera.

Those of you who have followed the activity of narrow-band television know that the system in use is a compromise between three interrelated factors; namely, bandwidth, transmission time per frame and picture detail. The SSTV-signal can principally be described as a voltage-controlled subcarrier of 1500 hz that is periodically shifted down to 1200 hz for sync-information and then is varied from 1500 hz to 2300 hz for video information. 1500 hz is black, and 2300 hz is top white. The occupied bandwidth is about 2500 hz, and it takes 8 seconds to transmit one picture. The pictures have a resolution of about 120 lines in horizontal and vertical direction.

A few words about the system parameters: In general, the greater the deviation in an FM-system, the better the signal-to-noise ratio in the presence of a given amount of interference. The maximum allowable deviation is determined by the bandwidth available and the maximum modulation frequency. Commercial facsimile operations have standardized on a frequency shift from 1500 to 2300 hz to represent the transition from black to white. When used with radiotelephone equipment having essentially flat response from 1200 to 2500 hz, modulating frequencies from 0 to 900 hz can be reproduced. If the white frequency is made much higher than 2300 hz, it will be attenuated by the audio cut-off characteristics of some transmitters and receivers. If the black frequency is made much lower than 1500 hz, the number of subcarrier alternations per picture element drops to too low a value, and horizontal resolution is lost. 1500 and 2300 hz are therefore adopted as the standard black and white frequencies with shades of gray being represented by frequencies in between.

To retain the advantages of amplitude limiting for the transmission of sync as well

as video, a sync frequency of 1200 hz is employed. A horizontal sync pulse is transmitted as a 5-millisecond burst of 1200 hz tone and a vertical sync pulse as a 30-millisecond burst. To permit the transmission of horizontal resolution equivalent to 120 lines, a horizontal sweep rate of 15 hz is selected. To give a 120-line raster a vertical scanning rate of 8 seconds is used.

The sweep frequencies are not at all critical and may be plus or minus 10% or more without seriously affecting the usefulness of the picture. For best results the sync frequency should be kept within 50 hz of 1200 hz. The black and white sub-carrier frequencies may be off 100 hz without causing trouble. A plus or minus 20% tolerance on the sync pulse duration should be all right.

The system can be used with any type of single-sideband equipment. The camera output is simply connected to the microphone input of the transmitter and the monitor to the audio output of the SSB-receiver. An audio tape recorder can be used to advantage for recording or playing back pictures.

This amateur slow-scan television system was developed by Copthorne MacDonald, WA2FLJ, about ten years ago. Today there are about 75 slow-scan amateurs in the United States and Canada.

Because it is impractical for me to describe the slow-scan equipment in detail, it may suffice to mention that the heart of the monitor is a cathode-ray tube with a long persistance screen, such as 5FP7 or 5ADP7. The signal is fed via the input limiter stages and video discriminator to the video amplifier, detector and filter and modulates the beam current of the CRT thereby producing brightness variations. The sync signal is separated in the sync discriminator, is amplified, rectified and used to control triggering of a horizontal and a vertical multivibrator which delivers drive pulses to discharge tubes. Across the load resistor of each discharge tube is generated a sawtooth voltage for the sweep amplifiers.

A slow-scan camera looks very much the same as a conventional fast-scan camera. A horizontal and vertical multivibrator generate sawtooth waveforms and retrace pulses for blanking. To minimize hum-effects, the vidicon beam current is chopped at a 10 khz rate. The signal is amplified in the video amplifier and the output is connected to a modulator which shifts a voltage controlled subcarrier oscillator from 1500 hz to 2300 hz depending on the level of the light falling on the vidicon target plate. Sync signals from the vertical and horizontal oscillators are combined in the sync mixer, and the resultant composite sync signal is connected to the modulator which shifts the subcarrier down to 1200 hz.

Many American amateurs use the Westinghouse 7290 vidicon, which was especially designed for slow-scan. In the camera an electro-mechanical shutter synchronized with the vertical retrace exposes the photoconductive layer of the vidicon for a fraction of a second at the beginning of each frame scan. This exposure establishes charge patterns in the photoconductor that are scanned off by the electron beam. In addition to giving rise to a varying electrical output signal, the beam also erases the previous scene's charge patterns and readies the tube for another exposure. Conventional vidicons act in a similar manner when scanned at 25 frames per second but are unsatisfactory when shuttered and when scan rates are slowed down because the charge patterns leak away too rapidly.

Some amateurs, for instance Ralph Taggart WA2EMC, have proved the possibility of using unshuttered conventional vidicons. My present camera uses the well-known 55875 Plumbicon by Philips, which has a very low dark current at the slow scan rates used. Most conventional vidicons, however, have a too high dark current with these sweep rates, and they are not able to erase immediately the previous picture.

Because of the slow scanning rates, a slow-scan TV camera requires much more time and patience to adjust initially than does a conventional fast-scan camera. With normal TV 25 complete pictures come along every second and one can see the results of an adjustment immediately. Not so with slow-scan TV; one must wait at

least eight seconds to see the results of many adjustments.

Because of these disadvantages and the time-consuming setting-up procedure, some amateurs have started designing sampling systems. These consist in short of a normal fast-scan camera, the output of which is sampled to synthesize a slow-scan signal. A normal fast-scan monitor is used to quickly set up the camera for optimum focus and contrast and by the flick of a switch the system is made to work in the slow-scan mode.

One cheap and very simple method to generate very high quality slow-scan pictures should not be overlooked. That is the use of a flying-spot scanner. In this system a raster is produced on the seven centimeter screen of a cathode-ray tube with short persistence. The light from the raster is focused on the transparent photograph to be transmitted, passes a set of condenser lenses and strikes the photocathode of a photomultiplier tube. The optical signal is amplified several thousand times by the photomultiplier and is then fed to the modulator. The rest of the circuits correspond to those of a slow-scan camera.

Here in Sweden, we still operate slow-scan on individual temporary permissions valid for one year at a time. Last year the American FCC and the Canadian Department of Transport authorized slow-scan television for the North American amateurs. For the United States the segments chosen are those which after Nov. 22nd, 1968 are restricted to holders of Advanced and Extra Class licenses, whereas in Canada parts of the phone portions in general are allocated for SSTV.

It is interesting to note some comments by the FCC in its report following the authorization as quoted by QST, Sept., 1968:

> Generally the recommendations for reduced frequency availability or for operation in telegraphy sub-bands were based upon the fear that disruptive or destructive interference to telephony communications would result from narrow-band TV. Since May, 1966, a number of amateur stations throughout the United States have been authorized to transmit slow-scan TV signals for test and demonstration purposes. No cases of interference resulting from these authorizations have been reported to the Commission. Slow-scan TV is more susceptible to interference than is radiotelephony requiring a ratio of desired to undesired signal of 10 db to 20 db for marginal or good picture quality. This requirement would appear to be such that slow-scan TV would generally not be used in the more heavily populated portions of the available frequency bands. Furthermore, there is some evidence that a single-sideband transmitter, operating in the slow-scan TV mode within the same bandwidth as radiotelephony, has less interference potential than the same transmitter using radiotelephony at its rated peak envelope power.

The first transatlantic two-way SSTV contact was established on June 24, 1968 by Syd Horne VE3EGO, in Ottawa, Canada, and SM0BUO in Stockholm, Sweden. Since then many contacts between North America and Sweden have been carried out. My friend, Willy Everaert ON4WM will demonstrate for you, besides SSTV from my own equipment, also tape-recorded transmissions over the air by W4ABY, W2PMV, W9NTP, VE3EGO and WB2LUM. These specific transmissions were made on 28.7 mhz and will give examples of how interference and fading affect the SSTV signal. The transmission from Don Miller W9NTP is of outstanding quality. His signals peaked 30 db over S9 at that time.

It is certainly possible to further improve the transmitting and receiving slow-scan equipments. I hope that with this little lecture some more European amateurs will become slow-scanners and help to create world-wide visual amateur communication.

Note . . . SMØBUO

Information about ATA International may be obtained from Mr. Erik Platteeuw ON4LP, Oude Brusselseweg, 119, Gentbrugge, Belgium.

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters have been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

Robert Wood KØHUD
510 Elm Street
Vermillion, SD 57069

Amateur Radio in the Classroom

It is becoming increasingly important that amateur radio attract the youth of our nation into its ranks. Many times I have heard amateurs speak of recruiting the students from the junior and senior high school, but very seldom do I hear the phrase, "Let's try to recruit some of the students from the elementary school." While teaching in the elementary school, working with high school students in amateur radio, and presently teaching on the university level, I have had the opportunity to analyze students according to their interests, motivation, and available time. It becomes apparent that students in the upper elementary grades (4, 5, 6) would be very receptive to an amateur radio recruitment program. My objective is to discuss an experience in one of my classrooms and how we might be able to interest more elementary grade children in amateur radio.

Try Ham Radio

When conceiving the idea of taking radio equipment into my sixth-grade class, I did not intend it to be an elementary recruitment program for future hams. It was meant to be an instructional lesson relating the fields of electricity, radio, and the art of communication. My radio was to be a culminating activity with all children having the opportunity to speak to hams in the United States, and hopefully, in another country. What actually happened became one of the happiest and most exciting experiences in my teaching career.

While teaching an instructional unit one day, I mentioned that I would be bringing my amateur radio set into the classroom. A few of the boys had a somewhat foggy idea of what this meant, but the majority of the children had never been exposed to this media of communication. After making the proper arrangements with my principal, who was strongly in favor of the idea, and erecting a multi-band antenna, I set up my transceiver one night after school with the aid of several curious children. That night I spent several hours in my room making sure that all equipment was in perfect operating order. Several parents called the school and wanted to know what was going on in my room. Curiosity was being generated!

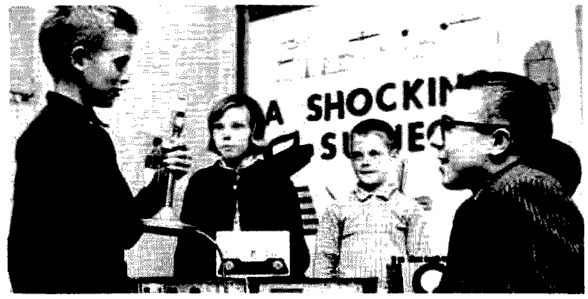
The next morning I checked into several nets from my classroom. It was the earliest I had been in the classroom all year. The children started arriving. "What's that?" "Can we listen to some music?" "Is that a ham radio?" I said nothing while trying to build up excitement and interest for the upcoming event. After the typical opening tasks—pledge to the flag, collecting milk money, and making sure all of the children were present—I proceeded to introduce my reading lesson for the day. Wow! The children just would not have that, at least not at this time. So, I decided to tune up the rig and attempt to make contact with some ham in the states. Still no formal introduction had been made of amateur radio. Contact was made with a ham in Minneapolis on 80. This is really nothing for an amateur radio operator living in Minnesota, but it is quite

an accomplishment to a neophyte. The children were just wild! Questions began to fly! "How does it work?" "May we talk over it?" Finally came the question, "Will you teach us something about that radio?" God bless that student. This was the moment I had been waiting for. Thet now wanted to learn about the subject because their interest had been stimulated.

Rumors mushroomed around the school. Students started coming into the room as early as 7:30 am. One morning there were over thirty-five fifth- and sixth-grade children talking and listening to hams around the country. I did not have to ask them to come. They were motivated by their strong interest and excitement of who would be next to talk into the microphone. Finally, several teachers asked if I would let other children come in and have the opportunity to talk over the radio. Why not! During the next few days over 175 students visited my room with well over 100 having the opportunity to talk. Many did not want to talk and they were not forced into doing so. On the last day of the week while we were making contact with several hams in California, Mexico, and the Canal Zone, a photographer from the local newspaper walked into the room. He, too, had heard of the excitement that had been generated by our radio. A picture and a short write-up telling about amateur radio in our classroom appeared in the next night's edition.

During that week, my class was exposed to new understandings relating to amateur radio. Also, they learned more geographical locations in five days than I had been able to teach them is several previous weeks. Why? Because now they had a purpose in locating and remembering the originating points of various contacts. All in all the week was most exciting.

After the radio was taken home, and the room started to get back into a normal routine, I had time for introspection. This had been one of the happiest moments of my teaching career. I did not have to motivate the children; they were motivated by amateur radio. I did not have to squeeze questions out of the children; they asked question after question because this was something exciting and something about



Try Ham Radio—A study of communications by the sixth graders of Robert Wood at Washington School was highlighted this week by an actual demonstration of "ham" equipment, owned by Wood, an amateur operator. Wood, shown at right above, looks on while Kim Schumann, 11, son of Mr. and Mrs. Milton F. Schuman, talks into the microphone. Other students in the picture are Denise Link, 11, daughter of Mr. and Mrs. Kenneth Link, and Steven Edgar, 11, son of Mr. and Mrs. William Edgar. During the week the children made contacts with an operator in Mexico, several in California, with a ship passing through the Panama Canal, and numerous contacts throughout the country. Youngsters in other classrooms at Washington visited Wood's room to view the unusual activities. The children also were taught how electricity is related to radio and communication. The bulletin board display in this picture centers around electricity.

(Post-Bulletin Photo)

which they wanted to learn. I found that many of the children were actually capable of learning things that I had thought to be too difficult. But, most important, I learned more about my children. They came early in the morning, at noon hour, and stayed late. During these periods we really got to know each other. And most hams would agree that getting to know people and to respect their interests is an important phase of amateur radio.

You Too Can Take Amateur Radio Into the Classroom

After this most enlightening experience, and reading Wayne Green's comments about getting new blood into the amateur radio ranks, I believe the following ideas will serve as a guide for other amateur radio operators to demonstrate their hobby in classrooms, and hopefully, to recruit a few new members.

There is a trend in public school education to enlist the aid of lay people to serve as resource persons to enrich the curriculum.

This may be the first important step in a planned recruitment campaign. I would recommend the following procedures to one interested in serving in the capacity of a resource person:

1. Contact the person responsible for the instructional program of the school. This person might be the superintendent, an assistant superintendent in charge of curriculum, or maybe the elementary school principal. Tell them what you could offer the teachers while they are presenting a science or social studies unit. Remember, when you are planning at this level, you must emphasize the instructional aspects and how this will aid the education of the child. We hope that we will interest some children to the extent that they will become amateurs, but first let's just expose them to this hobby for fun and enjoyment.

2. If you are the friend of a teacher, offer your services to help her teach a unit on electricity, radio, communications, etc. Again remember, we are trying to provide a service to the teacher. Once teachers find out about a person who is interested in children and education, half of the battle has been won.

Now that some form of initial contact has been made with the people responsible for the instructional program, what should you consider when you are called upon to serve as a resource person?

1. Get in contact with the classroom teacher. You may wish to ask the following questions: What instructional unit are you presently teaching and how will I be able to best serve you in your teaching? What grade level do you teach? How old are the children? Have they had any previous contact with amateur radio? What do you know about amateur radio? Could I give you some material to help prepare yourself as well as the children? Could I come to survey the classroom and area to determine the antenna placement and power outlets? (This could present a problem for some schools.)

2. Remember, the classroom teacher is the person directly responsible for the instruction of the children. Work closely with her and aid her in any way possible. Many teachers do not know about amateur radio and this may be their first contact with it. Expect questions that you may take for granted when it comes to your license, equipment, safety factors, etc. This is the time to remain cool, calm, and collective.

The big day arrives. The proper school contacts have been made; the antennas and equipment may be in place, or, depending upon the time factor, let the children watch you set it up. The children are anticipating the guest speaker who will demonstrate amateur radio. What do you do? How do you act with sixty eyes upon you? The following suggestions may make your first classroom presentation a bit easier:

1. Relax, this will be fun. Your voice has probably been heard by more hams at one time than by those who will hear you today.

2. Watch your vocabulary. These are elementary school children, not electrical engineers; however, don't coo and gurgle with them either.

3. Have your presentation planned. You will probably have only a set amount of time so know what you can do within that time limit.

4. There is an old Chinese proverb that

goes like this:

I hear and I forget . . .
I see and I remember . . .
I do and I understand . . .

Therefore, get the children involved in discussion, and most important, give as many children as possible a chance to speak over the radio. Some will be shy, so don't force them. There will be plenty of little "hams" in the room.

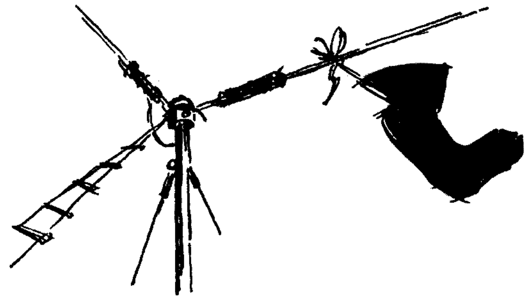
5. Conclude your presentation with the idea that if any of them are interested in learning more about amateur radio, they could call you or make personal contact. Give each student a qsl card.

After your presentation is concluded, equipment taken down, and you are preparing to leave, be sure to thank the teacher, principal, and others directly responsible for giving you the opportunity to demonstrate amateur radio. Today there are many pressure and hobby groups that wish to use the classroom for their own benefit. If we are to expose children to amateur radio, then we must sell the idea of how we can help the teacher and school educate the child. When you are in the school, you are teaching, recruitment of future hams is secondary in nature. If the children are impressed and genuinely interested, they will contact you.

After taking a poll of several elementary school teachers, principals, and superintendents in regard to utilizing amateur radio operators to enrich the school's curriculum, I found that 99.9% of those polled were excited and thought this to be an exceptional learning opportunity for children and teachers alike. Many teachers said they knew nothing about amateur radio but would like to learn more. This is a hobby that I have been engaged in since ninth grade. I wish an amateur radio operator would have visited my elementary classroom so I could have been exposed earlier to this worthwhile hobby!

Now that I am teaching at a university, I have wondered many times about the value of the amateur radio in my classroom. Recently, my ex-principal visited the university on a recruitment trip. According to him, my bulletin boards left something to be desired, but "project ham radio" left a lasting impression.

. . . **KØHUD**



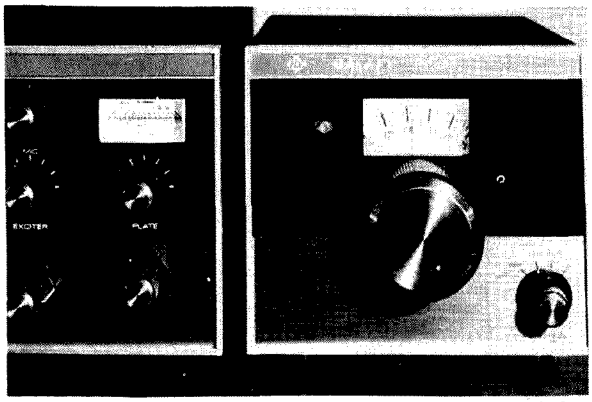
"A Ham's Christmas"

'Twas the night before Christmas, and from the hamshack
Came the warm glow of tubes from the transmitter rack,
The log had been brought up to date with great care
In case the FCC might some day be there.
Harmonics, XYL and all were in bed
(No Tennessee Indians to addle their heads).
I turned on the receiver, set the BFO,
And was just settling down for a long QSO
When up from the yagis arose such a clatter
That I yanked the big switch to see what was the matter.
Then between the dipoles and the Trap-Master beam
Came a loud shout, like a heterodyne scream:
"On, Clegg, Hallicrafters, on Collins and Elmac,
On, Allied and Daystrom, on Johnson and Eimac—
Up the mast clear to the corona ball,
Now dash away, dash away, dash away all!"
Quite suddenly, as I was turning around
Down the waveguide he came with a bound.
His nose was quite round, like an egg insulator;
His cheeks were as red as a hot oscillator.
A new microphone he held tight in his teeth
And coax encircled his head like a wreath.
I peeked from behind as he turned his back—
Was that my name on a new power pack?
He wasted no time, but went straight to his work
And when he had finished, he turned with a jerk;
Then laying a finger aside of his nose,
Saying, "Pse QSL," up the feeders he rose—
But as he departed after leaving the gear
"Merry Christmas to all!" I was able to hear . . .

Karl Beckman WA8NVW

Peter A. Lovelock W6AJZ
235 Montana Avenue
Santa Monica, CA 90403

The Galaxy RV-550 Remote VFO



If you are used to operating straight transceive at the home station, you may have become accustomed to the idea that a remote VFO isn't really a must. After all, don't we always work each other on the same frequency? So for operating convenience, isn't transceive the best mode? OK, I figured, it must be nice to be able to work stations in the foreign phone bands, but that was a luxury for the rabid DX hunters. And I *had* made DXCC in the U.S. bands. Who needed split frequency operation?

Just one week of using the RV-550 sure changed my ideas. Now I'm convinced that my station would be only half equipped with the transceiver alone, even if I never worked another DX station.

The Galaxy RV-550 Remote VFO is the natural companion to the GT-550 Transceiver (see 73, page 48, May, 1969) with the same elegant styling. Incorporating the same, four transistor VFO circuit that is a standard-of-comparison in stability, the RV-550 also has the identical 500 khz tuning dial and large spinner knob found on the GT-550. The *only* other control is a four position FUNCTION switch. I emphasize the word only because, unlike some remote VFOs, there is no separate band-switch control. Whatever band the GT-550 is switched to, so then is the RV-550. No chance of getting the VFO switched to a different band or having to fuss with several VFO segments within the same band. Simple, uncomplicated and a pleasure to use.

In practice the RV-550 adds three useful functions to its parent transceiver, without which its hard to imagine how I got along. The FUNCTION switch gives you these four options at the flick of a wrist:

1) OFF - Just what it says. The RV-550 is inactive (indicated by the dial light being out) and the transceiver operated in its normal mode.
2) REC - Receiver tuning is controlled by the RV-550, while the GT-550 dial sets the transmit frequency.
3) XMIT-REC - The RV-550 controls both receive and transmit tuning in transceive mode, while the transceiver VFO is inactive.
4) XMIT - This is just the reverse of function (2). Transmit frequency is set by the RV-550, while receiver tuning is accomplished with the GT-550 dial.

Very sophisticated, you say, but what do I get out of these several functions?

Well, suppose you are working a net and want to move off the control frequency to pass traffic with another member. He asks, 'where do you want to QSY?' You flip the RV-550 to REC and tune it to find a vacant spot. Switch to OFF, 'OK Chuck, 7275 is clear, I'll call you . Switch to XMIT-REC and you are transceive on the previously selected frequency to call him. And when you finish the traffic, switching the RV-550 to OFF puts you right back on

the net frequency, set by the transceiver dial. For emergency work you can transceive on two net frequencies, switching between them as the situation requires without touching the tuning knobs. Great for inter-net liaison.

You are not a net man? Well, maybe you have worked one of those nomadic types, destined to wander away up frequency. Tracking him with the transceiver dial means that he won't find you where he left you, and his anguished cries will seemingly go unanswered. Or if he has one of those transceivers with a 1 khz difference between transmit and receive, you both 'bunny-hop' some 10 khz in the course of a few overs, tromping across other QSOs on the way, and leaving a lot of blistered feelings. In either case the REC function is good for holding on to the nomad, while maintaining your transmit frequency stable.

While waiting for that rare DX to wind up his contact with a long-winded W6, you can put the RV-550 on REC to scan for other hot ones, with the capability of going on XMIT-REC to get a quick contact, then to OFF and the original frequency in time to catch the rare one as he gets his last of a string of 73s. Handy for contest flexibility.

If you're wondering what function 4 is good for . . . . .! The VK9 you can copy loud and clear says you are clobbered and begs you QSY up ten, which he finds to be in the clear. A quick check on REC proves this spot is solid QRM at your end. No mind—tell him to stay put, switch to XMIT and tune the RV-550 to the frequency he can hear you.

Hooking up the RV-550 to the GT-550 requires all the time it takes to plug in the two cables supplied, between the units. The GT-550 furnishes the regulated 12VDC. Hardest part is getting the VFO out of its shipping container—those Galaxy packers must be trying to set standards for the I.C.C. when it comes to protecting their wares.

Oh! By the way, the RV-550 is also fine if you are a rabid DXer and want to work the fellows in the foreign phone bands.

. . . W6AJZ

Jim Ashe

Calculation Made a Little Easier

If you have trouble working with numbers and simple calculations in electronics, you have lots of company. The standard American high-school mathematics program comes close to 100% efficiency in producing graduates who cannot avoid having real trouble with even the simplest mathematical calculations. A part of the reason was uncovered a few years back by the American Mathematical Association in a survey which disclosed that better than 50% of high-school math teachers were afraid of mathematics. And that indicates you have probably been exposed, in your formative days, to one or more such teachers. Very unfortunately, fear is contagious.

Probably you have noticed when a man is afraid of something, if he has to work with it, he becomes slow, tense, and cautious. His chances of making a mistake may actually be increased, yet error may be what he most wants to avoid. How about that? Does this resemble your style of doing calculations?

Yet, if you cannot handle even simple math, you suffer under a very considerable handicap. Electronics is a very fine hobby, but it is a better one if you can estimate appropriate component sizes, circuit voltages, signals, and the results of wiring changes. Perhaps you have to compete in your work for promotion, or even for a job, against another person who can handle mathematics better than you can. This can be a terribly serious affair, and very frustrating too. Here are two key ideas that will help you to use mathematics more effectively, and in the rest of the article I will apply these key concepts in several different ways.

My first point is, school mathematics is unnaturally perfect. Teachers, typically, lack engineering or scientific experience, and they draw very sharp lines between "right" answers and "wrong." These differences only rarely exist in real life, yet if you retain these false standards in the back of your mind when you are using figures and equations you may try too hard to avoid error. And, as a result, fall into it.

And the second key point is that mathematics is a practical art. You do not believe that? Then, if you have never thought of it from this perspective look at the instant results obtained by thinking about resistors, capacitors, signals, alternating voltages, antennas, transistors, you name it. The language of electronics, as of the science from which that electronics is derived is mathematics. This fact is only doubtful because of the large amount of purportedly technical electronics study material presented "without that math jazz." The man who has mastered this kind of learning comes to an instant halt when asked to design even a simple circuit, and will frequently make only slow progress when required to service a circuit that needs only a little more talent than plugging in tubes.

That's most circuits, nowadays.

Now, About Numbers

Numbers become much easier to work with after we find out something about how they are made up. They are quite interesting and some people become extremely enthusiastic experimenters, working with pencil and paper to discover new things about numbers.

1
2
3
4 USE TERMS
5 "DIGIT" OR "INTEGER"
6
7
8
9

10 INTEGER TEN, COMPOSED OF DIGITS ONE AND ZERO
⋮
372 INTEGER THREE HUNDRED SEVENTY TWO, COMPOSED OF DIGITS THREE, SEVEN, AND TWO.

Fig. 1. Terms "digit" and "integer" have same meaning at low end of the number scale, but different meanings for values over nine.

Very often when we are talking about numbers, we use two new words. See Fig. 1. These terms enable us to avoid confusions which might arise in saying, for example, "This number is composed of the numbers . . . " Instead, we say, "The integer 456 is composed of the digits four, five, and six." "Number" is a rather nice word in itself but rather general and so I will use the new terms when I need to be accurately descriptive.

14,756 equals 10,000	(ONE TEN-THOUSAND)
plus 4,000	(FOUR THOUSANDS)
plus 700	(SEVEN HUNDREDS)
plus 50	(FIVE TENS)
plus 6	(SIX UNITS)

Fig. 2. This is how a large value is built of decreasing decimal products. Digit value increases to the left.

Here is a rather sizable number: 14756. This integer is actually a shorthand description of a sum, which I have worked out in Fig. 2. Here we discover it consists of a principal part of 10,000 plus assorted smaller parts adding up to a respectable amount in themselves. They make up nearly one-third of the total amount, and could never make up one-half of it. Why is that? Now, since the units, the tens, and maybe even the hundreds, do not add up to much compared to the thousands and ten-thousands, why not drop them off so we can work with a simpler integer when calculating? Engineers do this routinely, and it is called "rounding off."

Sometimes it is convenient to break down integers in another way. This is called factoring, shown in Fig. 3. Here we see, for instance, the integer 1758 is obtained by multiplying 2 x 3 x 293. When you have done a lot of numbers work you tend to watch out for this structure since you may be able to find an easier way to do the calculation. Some handbooks contain tables of factors and primes and if you can find such a table perhaps you'll find it surprisingly interesting.

$$4 = 2^2 = 2 \times 2$$
$$114 = 2 \times 3 \times 19$$
$$247 = 13 \times 19$$
$$616 = 2^3 \times 7 \times 11$$
$$1758 = 2 \times 3 \times 293$$
$$1759 \text{ is prime}$$
$$1760 = 2^5 \times 5 \times 11$$

Fig. 3. Most integers are composed of smaller integers taken as a product, but a few "prime" integers are not factorable.

A prime number is one which is not divisible by any smaller number, without something left over. If we divide our 1758 by 2, which goes perfectly into it, the remaining integer is 3 x 293. Then we can divide out the three, leaving the 293. But the 293 is prime, since there is no smaller number we can divide into it without a fractional remainder.

Numbers can become real friends, with some practice. You can learn many things about them, and if you look around you find them in almost everything men do, and in nature too. Many plants grow according to numbers and simple mathematical rules. If you would like to develop some feel for this subject, there is probably no better book available than *How to Calculate Quickly*, by Henry Sticker, from Dover Publications.

Sticker provides a series of step by step exercises, which serve the same purpose as throwing and catching a baseball again and again, just for practice. After a little while you discover a growing feel for what numbers are and do, and they become familiar, reliable friends. Only patience is required. Intelligence has far less to do with it than most people believe.

Rounding Off Numbers

When I have to work out a calculation, my first step is to bring together neatly all the numbers I need to work with. If the calculations are involved the figures go in a handy column at the right hand side of the paper (I'm a southpaw) and maybe I add a few notes on where some of them came from in case I should want to check back later to verify accuracy. But for simple calculations I will usually write the numbers in where I am going to use them. Maybe I look again at one or two of them because I want to be sure they are correct and that I did not transpose digits anywhere. That is, I did not copy 6902 as 6092, for example.

Next, I round off any integers that have too many complicated digits. This will make the calculation much easier. For an example of what you can gain by rounding off integers, see Fig. 4. Here I have rounded off two integers by replacing digits with question marks, and we see that rounding off reduced the job of multiplication by better than half. It reduces the possibility of error, too, and improves the chance that when you make an error (and we all do) it will be easier to find, and you may even spot it immediately after you goof.

```
       1.2 ? ?
     x 1.2 ? ?
     ---------
       ? ? ? ?
     ? ? ? ?
   2 4 ? ?
 1 2 ? ?
 -------------
 1.4 ? ? ? ? ?
```

Fig. 4. Replacing one half the digits in this multiplication problem has reduced the work by more than half. If we removed uncertain or unnecessary digits in this way, there would be no loss of accuracy for practical purposes.

Now let's think about a familiar number, often used. Some well-intentioned but not very mathematical state legislator once proposed a law making pi exactly equal to three. I read about this in the writings of a man who felt the idea was pretty ridiculous since pi is a natural number, which the mathematicians call a non-terminating decimal. As originally proposed the idea *is* ridiculous, but it also started me writing this article, and now we are going to take a second, practical look at it. What does this do to the accuracy of our calculation if we go ahead and use this pi equals three value?

It's instantly clear a calculation with a 3 in it will be far easier to do than the same calculation using a 3.14159... And if we work out the percentage error this modification introduces, we discover it brings in a minus 4.5% error. Since we conventionally use 10% or even 20% components, we can usually ignore that 4.5% error and avoid some useless work. Now let's go into the ideas behind rounding-off numbers. A little knowledge can be a dangerous thing, you know.

Looking back at Fig. 2 we see that some digits are more "significant" than others. The left-hand digit, representing ten-thousands, carries far more of the total value of the integer than does the hundreds digit. This key point, taken with some thoughts about error and percentage accuracy, enables us to work out a practical view of rounding off for electronics calculations. We can round off many significant digits to two and occasionally three, but if we round off to one significant digit we often generate unacceptable error. Sample calculations in Fig. 5.

Original integer	Rounded integer	Percent error
1.1	1	-10%
1.4	1	-29%
1.5	2	+33%
1.6	2	+25%
1.9	2	+5.3%
2.1	2	-4.8%
2.5	2	-20%
5.1	5	-2%
5.5	6	+8.3%
9.5	10	+5.3%
9.9	10	+1%

Fig. 5A.

Original integer	Rounded integer	Percent error
1.11	1.1	-0.9%
1.14	1.1	-3.5%
1.15	1.2	+4.3%
1.16	1.2	+3.4%
1.19	1.2	+0.8%

Fig. 5B.

Fig. 5. The effects of rounding off depend on the change in effective size of the integer. Rounding off two digits to one as in 5A will often introduce sizable errors. Rounding three digits to two can never introduce more than 4.3% error.

The best case of rounding off two significant digits to one is rounding 9.9 to 10, or 9.1 to 9, and here we find about 1% error introduced. But at the other extreme, if we round off 1.5 to 2 we find a 33% error. The change in value is very great.

But if we are rounding off three digits to two, the very worst possible case is rounding off 1.15 to 2, which introduces a 4.3% error. Any other rounding off 3 digits to two will cause a smaller error. Briefly, we can round off two significant digits to one if the difference is not too great, and we can practically always round off three significant digits to two.

Rounding off is not merely a matter of dropping digits and increasing the remaining RH digit by one if the next digit was a five. See **Fig. 6.** When the next digit is a five, we always terminate the rounded integer with an even digit. This strategy averages rounding errors over many calculations of the same type, and offers the convenience of an

	5 to be dropped,
3.75 — 3.8	always round to
3.85 — 3.8	even integer.
3.95 — 4.0	
4.05 — 4.0	

Fig. 6. We always round off to next higher even digit preceding a dropped five.

even number to work with. Maybe we can factor out the 2 and use it elsewhere.

Standard Notation

Let's review our discussion of rounding off numbers. We can easily reduce any complicated integer to a simpler one, probably consisting of two nonzero digits and a collection of zeroes at one side or the other to fill spaces out to the decimal point. When we use these rounded-off integers in calculations, we work with the nonzero digits, and the zeroes come along to help us find the decimal point's location when the work is done.

Why not separate the nonzero digits – the significant digits – from the rest of the number? Then we could do our calculation with a really minimized effort, and catch up on the zeroes and decimals later. And this would make our calculations more reliable too, since if we could reduce all numbers to significant digits between say one and 10, we would be able to use an intuitive check on the accuracy of our result. For example, if our calculation boiled down to something like 5.4/2.6, we see instantly the result has to be near 2. Is there some way we can do this?

Yes, and it is called "scientific notation." Science is no respecter of human abilities and presents scientists with numbers larger than the mass of the universe in grams and smaller than the radius of the electron in meters. Very dissimilar numbers often appear in the same calculation, and so scientists and engineers commonly use scientific notation as a way of keeping their integers down to a usable size and variety.

Here is the key point. The numbers we use cover a range from indefinitely near zero up to very, very large. There is another matching set, exactly the same but provided with a minus sign, on the other side of zero. See **Fig. 7.** Here I have written out several of

Original integer	Scientific notation	Metric prefix
.	.	
.	.	
etc.	.	
1,000,000	10^6	mega
100,000	10^5	
10,000	10^4	
3,000	3×10^3	
1,000	10^3	kilo
300	3×10^2	
270	2.7×10^2	
100	10^2	
30	3×10^1	
10	10^1	
1	10^0	
0.3	3×10^{-1}	
0.1	10^{-1}	
.03	3×10^{-2}	
.01	10^{-2}	
.003	3×10^{-3}	
.001	10^{-3}	milli
.0003	3×10^{-4}	
.001		
.0001	10^{-4}	
.000001	10^{-6}	micro
etc.	.	
.	.	
.	.	

Fig. 7. Practice writing numbers in scientific notation by making up new ones to go between those shown, and then venture off the ends of the scale. Where do metric prefixes giga and pico go?

these integers, namely some of those close to one (1). You can extend this list as far as you please towards zero, although you will never reach it, and as far as you wish towards infinity. You have no chance of reaching that either, since somebody can always write down a number smaller or larger than your best.

Yet however far you go you can always write your integer in the simpler form of Col. 2. Here I have rewritten it as a pair of significant digits with a ten-power supplement which tells you how far to move the decimal point, and which way, to reconstitute the original integer. The ten's exponent indicates the decimal must be moved to the right or if the exponent is negative you must put the decimal off to the left. Try writing down some numbers between those provided, and then some larger or smaller ones than any written here, and you will shortly develop a strong feel for this notation. You're getting it when you discover this sequence forms a kind of rainbow of numbers.

I've listed the familiar metric prefixes in the third column. Here you see the prefixes are made to order for use with the scientific notation system. Indeed, I think they fit in so well because that is where they came from. Note the engineer thinks in terms of numbers from one to one thousand, and you will too if you practice for a while.

Kicking Ten-Powers

Once we have a number rounded off and then converted into scientific notation form, we are nearly ready to calculate with it. But first we may want to make some changes, just for convenience, and there are two kinds of alteration we may find useful.

Both hinge on the nature of the ten-powers left over after we have sorted out the significant digits. You can trace these out in detail by imagining multiplications and divisions by tens, and you will soon master a shorthand-like skill for this simple work. The first question is, what do you do with a ten-power placed under a fraction bar?

Chances are you move it upstairs, since that is where your answer comes out. To make this change you simply cross out the ten-power under the bar and write it above the bar with its sign reversed. That is, if you have a 10^3 under the bar you replace it with a 10^{-3} upstairs. Here is an interesting thought: what if you had a 10^3 on *each side* of the fraction bar?

That would be as if we wrote down a 1000, and divided it by 1000. A one (1) must come of this. So we rewrite our $10^3/10^3$ as $10^3 \times 10^{-3}$, and the only way we can get a result of 10^0 or one is to *add* the exponents. Several examples are provided in **Fig. 8.**

$$10^3 = \frac{1}{10^{-3}}$$

$$\frac{10^3}{10^3} = 10^3 \times 10^{-3} = 10^0 = 1$$

$$\frac{10^7}{10^4} = 10^{7-4} = 10^3$$

BUT

$$\frac{10^7}{10^{-4}} = 10^{7+4} = 10^{11}$$

$$\frac{1}{860} = \frac{1}{0.86 \times 10^3} = \frac{1}{0.86} \times 10^{-3} = 1.2 \times 10^{-3}$$

$$\frac{30 \text{ mh}}{120\text{K }\Omega} = \frac{3 \times 10^{-2}}{1.2 \times 10^5} = \frac{3}{1.2} \times 10^{-7} = 2.5 \times 10^{-7}$$

Fig. 8. Ten-powers can be moved around before and during the calculation to make the work easier.

And the other change you may want to make is, what if one of the significant digit numbers is an inconvenient size? For instance, perhaps you have come up with an 860 and you would like to have a 0.86 because you are dividing and you see that dividing by 0.86 will make the answer rather larger than the numerator of your fraction. You probably see already that you convert the 860 to 0.86×10^3, and put the 10^3 upstairs or maybe you place it next to a handy 10^{-3} and they cancel to reappear as a one (1). Very often in electronics work you would break up a 10^{-6} into a $10^{-3} \times 10^{-3}$, and take out one or both its factors in this way.

With some practice you can quite confidently kick ten-powers around inside the calculation you're going to do before you come to the actual computation with the significant digits. This makes the work very much easier, and errors far less likely. Well, let's put all these ideas to work in some real electronics-type calculations.

Sample Real Calculations

We can begin with a very simple calculation that has a twist in it. I have a 1.2 megohm resistor and I think I should add a series 68 K resistor. What will be the result? Such a question could come up if we were doing bridge test on some resistors to choose a pair adding up accurately to some predetermined value. The twist is, to add these values using scientific notation. See **Fig. 9.**

1.2 megohms	$= 1.2 \times 10^6\ \Omega$	$1.2 \times 10^6\ \Omega$
plus		
68K ohms	$= 6.8 \times 10^4\ \Omega$	$.068 \times 10^6\ \Omega$
	Cannot add these!	$1.268 \times 10^6\ \Omega$

Fig. 9. When adding numbers in standard notation, change them all to the same ten-power suffix, and then add in the usual way.

When we add numbers in scientific notation, we must cast them all into the same form. Each must have the same ten-power multiplier. If we added a ten and a hundred but forgot to make this correction, we could wind up with a twenty or a two hundred, both quite in error. If we kick tens the hundred can be written as ten tens so that we wind up with a sum of eleven tens or 110, or we can do it in hundreds terms.

Now here is a familiar simple circuit. It is a simple rc circuit whose characteristics we see at a glance. At very low frequencies the capacitor has inappreciable effect upon the signal, and at very high frequencies the capacitor shunts the signal irresistibly to ground. At some intermediate frequency the capacitive reactance equals the resistance and the two components act as a voltage divider. This is the familiar minus-3-db corner frequency, and we want to calculate this frequency for the network shown. See **Fig. 10.**

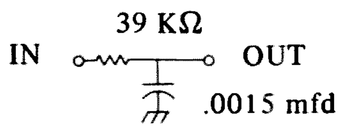
Perhaps we don't recall just what the equation is, so we write down something like it: resistance equals capacitive reactance. The f and the R change places, and we have the relation needed. Since there are so few numbers to plug in we bypass making a neat table and write the values directly into it. Besides, they are instantly available from the schematic.

If we call pi equal to three and double it, that doubles the rounding error but everything else too, so the percent error is the same. The resistance 39 K ohms becomes 4×10^4 ohms, and the .0015 mfd capacitor becomes 1.5×10^{-9} farads.

I didn't plan it that way but all this works out very easily to 36×10^{-5}, and then we kick exponents to discover a fraction practically the same as 3. The answer is 3 khz.

Now we can work this out in more detail to discover how our approximate answer lies in regard to all the possible answers. Yes, there are many possible answers because we did this one using nominal values for the components. In real life each has a tolerance of plus/minus 10% or more! Repeating these calculations in a more detailed and tedious way (I used my slide rule) brings the result our exact answer is very near 2.72 khz, and with real 10% components we should find a minus 3 db point between about 2.15 khz and 3.29 khz. Our approximate answer was safely within these limits.

Here is an example that demonstrates how easily we can work with numbers very different in value. How many electons could we place side by side across the diameter of



$$R = \frac{1}{2\pi fC}\ ;\ f = \frac{1}{2\pi RC}$$

$$f = \frac{1}{2\pi \times 39\ K\Omega \times .0015\ \text{mfd}} = \frac{1}{6 \times 4 \times 10^4 \times 1.5 \times 10^{-9}}$$

$$f = \frac{1}{36 \times 10^{-5}} = \frac{100}{36} \times 10^3 = 3\ \text{khz}$$

Fig. 10. RC calculation becomes simpler with each step before doing multiplication and division. It becomes so simple there is almost nothing to do!

Sun diameter 1,390,600 km
Electron radius 2.81751×10^{-13} cm

$$\frac{\text{Sun dia.}}{\text{Electron dia.}} = \frac{1{,}390{,}600 \text{ km}}{5.62502 \times 10^{-13} \text{cm}} = \frac{1.4 \times 10^{9} \text{ meters}}{.56 \times 10^{-14} \text{ meters}} = 2.5 \times 10^{23} \text{ electrons per sun diameter, approximately}$$

Fig. 11. This example shows that numbers of very different value can be as easy to handle as those not very different from another. We simply get an extremely large answer.

our sun? It must be very many. Looking up facts in a convenient handbook, I found the sun's diameter in kilometers and a nominal electron radius in centimeters. These values and the appropriate calculation appear in Fig. 11. Most of the work went into kicking tens around and although we may not be able to visualize 2.5×10^{23} electrons (I can picture 7 or 8, I think) we can work as easily with such a numerical value as we can with our old friend 47 ohms.

I haven't by any means exhausted the resources available for making calculations easier. But now you know a few of the basic ones, and you can look around for more. Practice helps wonderfully. There is one class of aids that deserves an article in itself which I have not mentioned yet. That is the various engineering aids available in a nearby book, a library, or an electronics supply house.

When you want to find a result, perhaps you can avoid calculations by looking it up. A handy engineering table may contain your problem all worked out. Or you may be able to use a graph, a nomograph (a sort of calculating graph) or a chart. Various slide rules and other calculators are available too, and all these tools can be used to make your work easier. Calculate if you must, yet always look for a better way to find your needed result.

Still, the key to using any of these aids is just the basic ideas I've set forth here. You can always use them. Good for you if you're using these tools already; this article will help you use them better. And if you haven't tried them yet, the concepts I've described will make mutual introductions much easier.

. . Jim Ashe

SOLUTION TO ACROSTIC

1.	Turkey	6.	Clipperton
2.	Romania	7.	Ecuador
3.	Antarctica	8.	Israel
4.	Navassa	9.	Vatican City
5.	Surinam	10.	Easter Island
		11.	Rodriguez

Universal Dual-Frequency Crystal Calibrator

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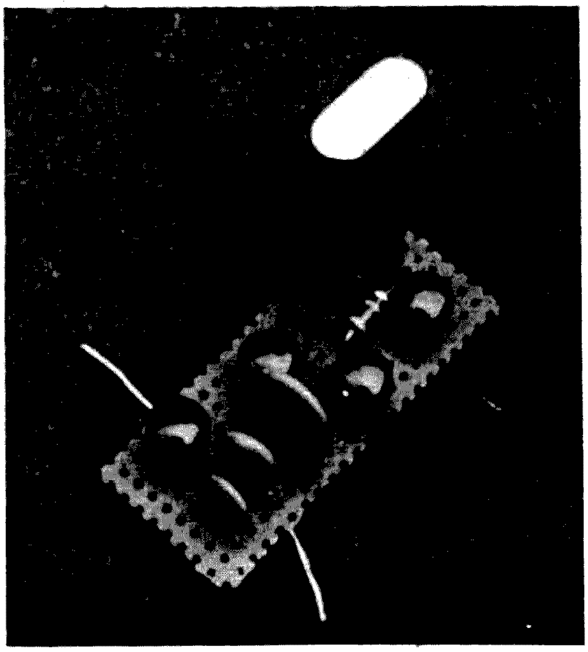
Brooklyn NY 11227

Here is a simple and inexpensive crystal calibrator circuit using IC.s which can be used as presented or expended to build a "tailored" calibrator for any receiver.

It is often desirable to have a crystal calibrator with two or more output frequencies and with a rich harmonic content so that searching for markers on the higher frequency bands, such as 10 and 15 meters, is made easier. Both of these goals are easily achieved by the use of digital integrated circuits. Furthermore, the whole calibrator unit is far simpler to construct and more economical than ever would be possible with either vacuum tube circuitry or discrete solid-state circuitry.

The calibrator to be described, which provides markers at the fundamental crystal frequency used, is termed "universal" for several reasons. No tuned circuits are used and the unit can be used with almost any crystal from 100 kc to about 10 mc and still provide a fundamental and half-frequency output. The stages are really "building blocks" and the unit can be expanded in any manner desired to provide multiple frequency outputs or to use any division ratio that is an even multiple of two. Thus, depending upon the calibration markings on the frequency scale of a receiver or transceiver, one can build a calibrator that will suit these markings rather than accept the output of a standard calibrator circuit.



Many construction possibilities can be devised. Here the calibrator is assembled on a 1-inch x 2½-inch perforated board. The placement of the IC's simply follows Fig. 2 with the two oscillator circuit μL914's next to the crystal.

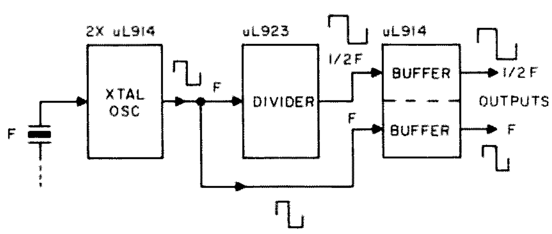


Fig. 1. Block diagram of stage functions in the calibrator.

Circuit Description

Fig. 1 shows a block diagram of the basic calibrator unit. Two Fairchild μL 914 units form the oscillator circuit. As can be traced by following the circuit diagram of **Fig. 2** and the internal μL 914 circuit, the oscillator is actually a multivibrator which is control-

led by the frequency of the crystal used. Circuit operation is very stable and the square-wave output not only has the desired richness in harmonics (remembering that a square wave is composed of a sine wave fundamental and an infinite number of odd harmonics of the fundamental), but is the required wave-form to operate the divider circuit.

The divider circuit uses a single Fairchild μL 923. The IC contains some 12 transistors in an arrangement known as JK flip-flop. It probably would only cause confusion to present the internal circuit of the unit, especially since its operation can be understood easily (for this application) simply in terms of its terminal functions. The unit can be regarded as a simple toggle switch that will only operate when it receives a positive going voltage (note that the voltage must be changing; a steady voltage does not affect it). So, if a square wave is applied which starts out positive, it will trip the switch. The switch will not be tripped again until the next square wave cycle. And again the switch will not be tripped until another whole input cycle occurs. Thus, the switch changes position half as fast as the input, and the output frequency is half that of the input frequency and also a square wave.

The buffer stage is not absolutely necessary but it does isolate the output from the divider stage and also insures a maximum voltage swing at the output. As shown in the insert diagram of **Fig. 2** there are really two separate dual transistor stages in the μL 914, and each of them is used as a separate buffer section—one for the fundamental marker output and one for the half-frequency marker output.

One can include as many divide-by-two μL 923 stages between the oscillator and buffer as desired. Only the final divided output can be used or one can switch-select outputs at the input and output of each divider stage. Some of the tradeoffs that might be involved in constructing a long string of dividers to obtain a given marker frequency are discussed later.

Construction and Adjustment

Fig. 2 shows the wiring diagram of the dual frequency calibrator. There is little more to the unit than the interconnection of

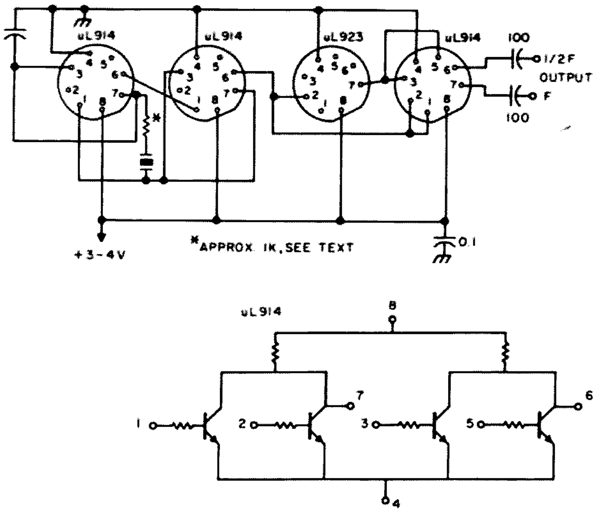


Fig. 2. Complete schematic of the dual frequency calibrator. Insert drawing shows internal circuit of the μL914. Terminal numbers for the IC's are shown as they would be seen viewing the units from the underside.

leads between the IC units. The photograph shows how this circuit was assembled on a piece of perforated board. The leads of the IC's were simply soldered directly together, although the use of IC sockets is recommended if one is not adept at soldering connections quickly, since excessive heat build-up can destroy the IC units. The circuit also easily lends itself to PC board construction.

The 1K ohm resistor shown in series with the crystal may have to be varied in value somewhat to achieve immediate oscillation upon the application of power to the unit. A 5K potentiometer can initially be used in place of the resistor to determine the resistor value required and then a fixed value resistor substituted. An oscilloscope is useful but not absolutely necessary at this point to optimize the square wave output shape of the oscillator. The oscillator will work with crystals up to about 10 mhz and a crystal switch can be used if desired to obtain a choice of fundamental frequencies. Each crystal should, however, be placed in series with an individual resistor of 1K ohm nominal value.

The output is taken from each section of the μL914 buffer unit through 100 mmf coupling capacitors and may be connected to the antenna input circuit of a receiver through a selector switch. The output may

also be connected to the secondary side of the input circuit of a receiver; but then the coupling capacitors should be reduced to a few mmf to prevent loading and detuning. One need use only as much capacitance as is necessary to obtain satisfactory signal output. With small amounts of coupling, satisfactory markers should be heard at least through 10 meters. Note should be made of the fact that when using both sections of the μL914 as buffers on different frequencies, some intercoupling does take place. The selected output will predominate, but the other output will also be heard. Normally, this condition has little practical drawback, but if it is desired to achieve maximum separation, only one section of a μL914 unit should be used per μL914 unit.

Normally, the slight adjustments necessary to choose the proper crystal circuit resistor and to couple the unit to a receiver are all that is necessary. No provision was made to "trim" the oscillator frequency for several reasons. When using low-frequency crystals (below about 500 khz), the accuracy will be sufficient for most normal uses. Also, normally this accuracy will be within that to which it is possible to adjust the crystal frequency by the usual audio zero-beat method. When zero-beating a marker with WWV, for example, the response of the audio system, headphones, etc., drops sharply below 50-100 cycles. So, there will be an uncertain area of about 100-200 cycles, anyway, using this method of adjustment where zero-beat seems to occur. However, in case it is desired to try to for more exact frequency output, a 15 mmf trimmer can be used either in parallel or in series with the crystal to alter its frequency.

The unit constructed used individual IC's which can now be obtained widely at moderate prices. If one builds a more elaborate unit the use of dual-IC's might prove cost saving.*

Expanded Circuits

As was mentioned before, as many μL923 divide-by-two units can be placed in series as desired. The output (terminal 7) of one μL923 unit goes to the input (terminal 2) of the next μL923 unit. Pin 4 of each unit is grounded and pin 8 goes to the supply voltage. In building a calibrator for a specific usage, however, it is worthwhile to explore the cost tradeoff between the μL923 units and the cost or availability of the crystal. Suppose, for instance, one desired to build a calibrator to provide markers every 20 khz to correspond to the frequency markings on a dial scale. **Fig.3** shows some of the combinations of crystal frequency and the number of μL 923 units that could be used. Normally, 40 or 80 khz crystals would not be feasible, but 160 khz crystals can be purchased for about $4. Also, many surplus low-frequency crystals are available at low prices which can be used. Many an odd-ball crystal frequency becomes very useful when one finds the right division ratio to use with it.

DIVISION RATIO	μL923 UNITS	XTAL FREQ (KHz)
2	1	40
4	2	80
8	3	160
16	4	320
32	5	640
64	6	1280

Fig. 3. Combinations possible to build a calibrator producing 20 kc markers.

Summary

I have tried to present a simple IC calibrator scheme which one can expand, as desired, to cover almost any marker-frequency need. Simple circuits have been used, although only slightly more complicated ones are available to allow frequency division by any number—not just even multiples of two. But, they are not suggested as a first-time project, and it is desirable to have test equipment available to check their operation. The divide-by-two circuits are essentially fool-proof, unless one makes a wiring error.

Power for the calibrator can be obtained from a fairly well filtered source in a receiver or from two 1½-volt batteries in series. A simple zener regulator circuit is advisable if the operating power is obtained from the drop across a cathode resistor or from a rectifier across the filament line in a tube-type receiver.

. . . W2EEY/1

*Poly Paks, P.O. Box 942, So. Lynnfield, Massachusetts 01940, for instance, markets the 6M4 unit for $1.49 which contains two complete μL914 "chips" and the 10M4 for $1.69 which contains two complete μL923 "chips."

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An excellent tool for removing burrs from small diameter holes can be made in a matter of minutes from a standard 3/8" or 1/2" bit and a knob with a 3/8" or 1/2" hole. Grind flats on the shank of the bit to allow the knob setscrews to seat, this will keep the knob from coming loose.

If you do not have a knob of the proper description (they are a standard item, but not too common) turn the bit shank down to 1/4" and use a standard 1/4" knob or buy a set of bits with the shanks already turned down. My local supermarket sells a set of imported bits with turned down shanks for less than a dollar. While not of very high quality, they will work quite well in this application. Any knob you use should be the type with a metal insert. The all plastic types will not last.

William P. Turner, WAØABI

The response to our ad calling for Distributors and Reps has been great. We now have more requests than we can accommodate, therefore we withdraw our plea. Thanks for your interest.

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E. Babudro VE3ECU/WØ
1426 E. 4th St.
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Versatilize Your Transceiver

If you are the type of fellow that likes to go down to the low frequency amateur bands (the dc bands) such as 75 and 40 meters and join in a round table or a net, then you probably felt distressed because you had to adjust your dial for every transmitter that was in the QSO. In most cases, being slightly off frequency is one of the evils that comes with having a transceiver with incremental tuning, because the thing is either misadjusted or else you forgot to zero the dern thing, or other innumerable reasons. Also the incremental tuning on my Eico 753 is so smooth due to the great bandspread that I wished to tune my transmit function with it as well. So, I put my thinking cap on and came up with a solution that makes it worthwhile to add this little tuning aid to rigs that do not have one.

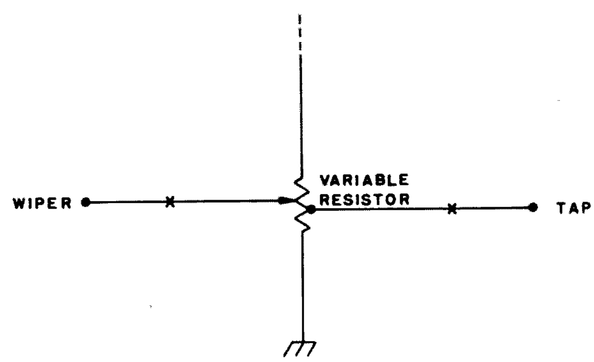
The incremental tuning device is basically made up of a varactor diode biased by a pot on the front panel. As you vary the bias on this diode, its interelectrode capacitance varies, and this variable capacity is applied across the vfo tank to vary the frequency. On transmit the bias is derived from a tap on the pot in my 753, thus making this frequency independent of the setting of the incremental tuning.

To effect the change you will need a double pole triple throw switch, four coded and cabled wires about four feet long (four lead intercom cable is ideal) and a soldering iron. A minibox in which to mount the switch would also be nice.

Locate the receiver offset potentiometer and disconnect the wire going to the wiper arm and the one going to the tap. Now connect two of the wires in your cable to this wiper arm and tap. Splice the two remaining wires in the cable to the wires that came from the wiper arm and tap and remember the color codes.

The other end of the cable goes to the switch as shown in Fig. 1b. The two points marked X were the original connections. If you wired the switch according to the diagram, you should have:

Position 1 - Receiver offset only (label R).
Position 2 - Receiver and transmitter offset (label RT).
Position 3 - No offset (label OFF).



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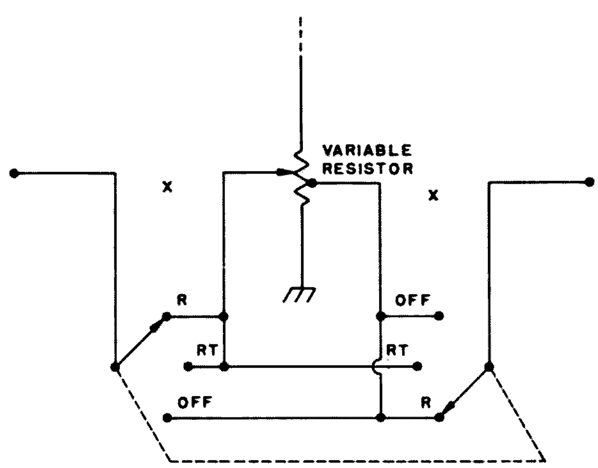

B

Fig. 1. 1a is the original circuit of the potentiometer that acts as the control. 1b is the same circuit with the switch added. Note that no permanent changes are made to the rig so as not to devaluate it, and it can be changed to the original condition in a couple of minutes.

The advantages of this conversion are as follows:

Position 1 is the same as you have now and there is no change in function. In position 2 or RT the frequency that you are receiving is the frequency at which the transmitter is tuned also. Use this position only to get a perfect zero beat or as a final touch up, never when searching for a quiet spot at the band edges. In position 2 you will also be able to correct for slight drift of the vfo and know that your transmitter is dead on your receiving frequency. In position 3 of your switch the offset feature is disabled, and whatever frequency you tune with your main dial will be both for transmit and receive. In this position if you are tuned in for receive properly, you know that you can't be blamed for being off frequency on transmit.

In case you like to operate in position 1, you can make a quick check by switching to OFF, tuning in a signal then switch to R (pos. 1). If the signal is off frequency now, loosen the offset knob, adjust the control for zero, beat on the signal, and tighten the knob with the hairline at exactly center or no offset. You should notice no difference in a received signal by switching between the OFF position and any other position when the offset control is adjusted correctly.
offset control is adjusted correctly.

After a little practice you will find that it is easy to monitor two frequencies slightly apart simply by adjusting your receiver to one with the main dial and to the other with the offset and then switching between OFF and R.

. . . VE3ECU/WØ

Articles We Would Like to See:

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Hams I Like . . . . .C. Evans (short-short)

The Editors

Tell Our Advertisers You Saw It in 73

Transistor Class B and C Power Amplifier Design

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North Balwyn, E9
Victoria, Australia

It is now possible to obtain transistors which are capable of producing up to several watts of rf power at frequencies into the UHF region. Some transistors are capable of producing 30 or 40 watts of rf up to 30 mhz–at a price of course! Most transistors are within the average amateur's budget though.

The design procedure, especially for AM, is somewhat different to tubes but it is *not* difficult and once familiar with it you should be able to complete a design fairly quickly. Don't let all the equations scare you, not all of them are used in a specific design. The equations are no harder to use than Ohm's Law, so little or no trouble should be experienced.

In this article I will not cover SSB and transistor Class A linears. This is not because I don't like SSB (I do), it's just that I have not experimented with SSB and transistor Class A linears. Sorry about that.

The following design procedure will be for Class B, zero bias, rf power amplifiers for the following reasons: (a) ease of design (I'm lazy); (b) less components necessary (I'm a miser); (c) greater power gain than Class C; (d) no need to provide or develop a reverse base bias source.

The first decision to be made is whether you want to build a CW/FM or an AM transmitter. Having decided that, you now decide on what peak rf power output (carrier power for CW/FM or peak rf power out at 100% mod. for AM) you want at the desired frequency. Keep in mind that if you want more than 1 or 2 watts at VHF then you must be prepared to pay out quite a few dollars for the privilege. The same might apply at hf, though more power can be obtained relatively cheaply at HF.

The second decision you have to make is, "Which transistor will I use?" You should obtain the data characteristic sheets of several suitable transistors (ask the manufacturer). Now pick the transistor(s) which will supply the rf output at the desired frequency. Check that the minimum gain–bandwidth product, ft, is 2 to 4 times the desired frequency. If this leaves you with several transistors, choose one with the highest hfe (high frequency current gain), or the cheapest.

CW/FM Design Procedure

(1) V_{CC} is determined from the following formulae:

$$V_{CC} \leqslant \frac{BV_{CES}}{2} \text{ or } V_{CC} \leqslant \frac{\text{max. } V_{CEO}}{2}$$

Where BV_{CES} is the collector-emitter breakdown voltage and maximum, V_{CEO} is the maximum allowable collector to emitter voltage. V_{CC} is less than, or equal to half the maximum allowable collector voltage because the instantaneous collector voltage swings to twice V_{CC} on signal peaks.

(2) Now the optimum collector load resistance is given by:

$$R_C = \frac{V^2_{CC}}{2P_f}$$

where P_f is carrier power decided above.

(3) Now you have to match the collector load resistance R_C to the output load R_L (see Fig. 1 (a) (b) and (c)). The problem here is to take C_O (the transistor output capacitance) into consideration. At HF C_O will, with most transistors, not be terribly significant. It may become a problem though at VHF. Now Figs. 1 (a), (b) and (c) give circuits for the Pi, T, and

parallel-tuned networks respectively. The Pi circuit is good where C_O is only very small or insignificant. Also the Pi network will feed through subharmonics of the output frequency, more so than the other networks. This may not be important. The T and parallel-tuned networks are very handy at VHF as C_O will not drastically affect them, note that they are easily adaptable to coaxial or trough-line configurations. For the design of these networks refer to the heading *matching networks.*

AM Design Procedure

(1) V_{CC} can be determined from the following formulae:

$$V_{CC} \leqslant \frac{BV_{CES}}{4} \text{ or } V_{CC} \leqslant \frac{\text{max. } V_{CEO}}{4}$$

V_{CC} is less than or equal to one quarter the maximum allowable collector-emitter voltage because the instantaneous collector voltage swings to four (4) times V_{CC} on modulation peaks. (100% mod.)

(2) Now the optimum collector load resistance (R_C) is given by:

$$R_C = \frac{3V^2_{CC}}{4P_f}$$

P_f = one quarter peak rf power at 100% modulation as decided previously.

(3) The matching network here is the same as for CW/FM procedure and the same remarks apply.

Matching Networks

The *Pi Network* configuration is shown in **Fig. 1** (a). The equations for determining the reactances of the components are as follows:

(1) $$X_{C1} = \frac{R_C}{Q_L}\left(1 + \sqrt{\frac{R_L}{R_C}}\right)$$

where R_L is load resistance (ie. antenna), R_C is optimum collector load resistance, Q_L is loaded Q of circuit. Practical values are in the range of 5 to 12.

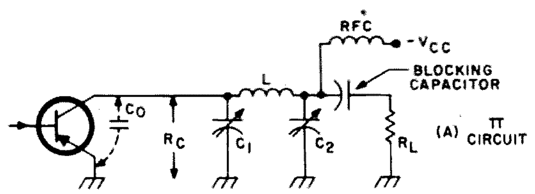


Fig. 1A. Circuit for the pi network configuration.

The capacitance of C_1 can be found from the nomograph on page 505 of the *Amateur Radio Handbook* by the R. S. G. B. or the *reactance chart* in chapter 2 of the *ARRL Handbook.*

(2) $X_L \cong X_{C1}$ 1. The inductance (L) can be found from the same handbooks mentioned above.

(3) $X_{C2} = X_{C1}\sqrt{R_L/R_C}$. The value of X_{C2} can also be calculated from the above mentioned handbooks.

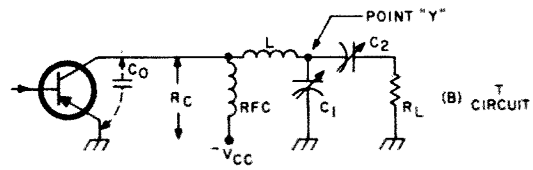


Fig. 1B. The T-network. In this circuit the loaded Q is increased by raising point Y above 1,000 ohms and transforming down to the load of impedance R_L.

The T–Network configuration is shown in **Fig. 1** (b). In this circuit the loaded Q is increased by raising point Y above 1,000 ohms and then transforming down to the load impedance R_L. The reactances of the components can be found by using the following equations:

(1) $R_Y = R_C\ (Q^2_L + 1)$

where Ry is the impedance at point Y, R_C is the collector load resistance, Q_L is the loaded Q. Practical values in the range 5 to 20.

(2) $$X_1 = \frac{R_y}{Q_L}$$

(3) $$Q_2 = \frac{\sqrt{R_y}}{R_c}$$

(4) $$X_2 = \frac{R_y}{Q_2}$$

(5) $$X_L = Q_2.R_c$$

(6) $$X_{C2} = \frac{R_L}{Q_L}$$

(7) $$X_{CL} = \frac{X_1 \times X_2}{X_1 + X_2}$$

The values of L, C_2 & C_1 can be found from the previously mentioned handbooks.

The *Parallel–tuned* network in **Fig. 1** (c) is a parallel-tuned circuit with the load tapped up the coil. The transistor is capacity coupled to the circuit via C_2. The coil, L, transforms R_C to a higher

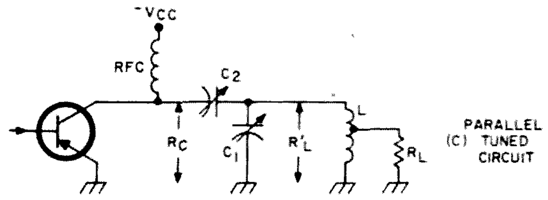


Fig. 1C. A parallel tuned circuit with the load tapped up the coil.

resistance R'_L. Now for practical circumstances the turns ratio is around 3 to 1 or 4 to 1. Thus: (a) $R'_L = 16\ R_L$ or (b) $R'_L = 9\ R_L$.

Above 100 mhz the equation in (b) should be used. Below 100 mhz the equation in (a) should be used.

The reactances of the components can be calculated from the following formulae:

$$(1)\quad X_{C1} = \frac{R'_L}{Q_L} \quad Q_L \text{ in range 5 to 15}$$

$$(2)\quad X_L = X_{C1}$$

$$(3)\quad X_{C2} = R_C\left(\sqrt{\frac{R'_L}{R_C}}\right) - 1$$

L_1, C_1 & C_2 can be found from the *ARRL* or *RSGB Handbook* as mentioned before.

Drivers

The driver has to deliver a certain amount of power to the base of the PA transistor, and this drive power (Pin) can be found on the manufacturer's data charts. A number of graphs will be given either showing rf power output (Pout) versus frequency for different values of Pin at a certain value of V_{CE} or a graph of Pout versus Pin for different values of collector voltages at a specific frequency. By referring to the appropriate graph the rf power needed to drive the PA (Pin) can be determined.

It will also be found necessary to match the driver to the PA base to achieve efficient power transfer. Keep in mind that these networks are not 100% efficient and allow for a reserve of power in the driver above that which is necessary to drive the PA.

By referring to **Figs. 2** and **3** it can be seen that the matching networks are similar to that in **Fig. 1 (c)**.

The equations for determining the components in **Fig. 2** are as follows:

$$R'_L = 16\ R_{in} \quad \text{or} \quad R'_L = 9\ R_{in}$$

where R_L is the resistance seen across the coil. R_{in} is the base spreading resistance (rbb) or hie of the PA transistor. The same remarks apply here as before.

Now, (1) $X_{C1} = \dfrac{R'_L}{Q_L}$ (Q_L in range 5 to 15)

(2) $X_L = X_{C1}$

(3) $X_{C2} = R_{CD}\left(\sqrt{\dfrac{R'_L}{R_{CD}}}\right) - 1$

The equations for determining the components in **Fig. 3** are as follows:

$$R'_L = 16\ R_{CD} \quad \text{or} \quad R'_L = 9\ R_{CD}$$

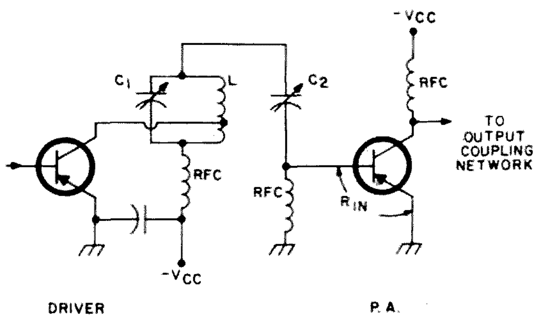


Fig. 3. R_{CD} is the collector load resistance of the driver.

Where R_{CD} is the collector load resistance of the driver found from the equation

$$R_{CD} = \frac{V^2_{cc}}{2\ P_{in}}$$

Pin from manufacturer's data sheet.

Now (1) $X_{C1} = \dfrac{R'_L}{Q_L}$ (Q_L in range 5 to 15)

(2) $X_L = X_{C1}$

(3) $X_{C2} = R_{in}\left(\sqrt{\dfrac{R'_L}{R_{in}}}\right) - 1$

Parallel and Push-Pull Operation

If you wish to achieve more power

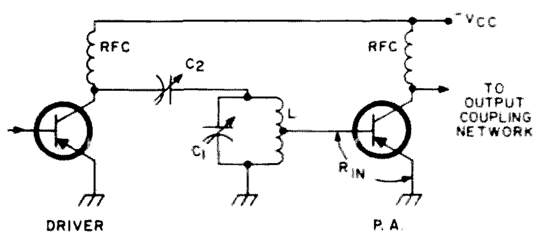


Fig. 2. R'_L is the resistance seen across the coil and R_{in} is the base spreading resistance.

output than one transistor will supply then parallel or push-pull operation could be employed.

Fig. 4 shows two transistors in a parallel configuration. The resistors in the emitters are to prevent one transistor "hogging" the current. The values of the resistors would be in the 1 to 20 ohms range depending on the power involved. Once initially adjusted so that the emitter currents of the transistors are equal, the circuit should okay. I would recommend that the T-network or parallel-tuned network be used

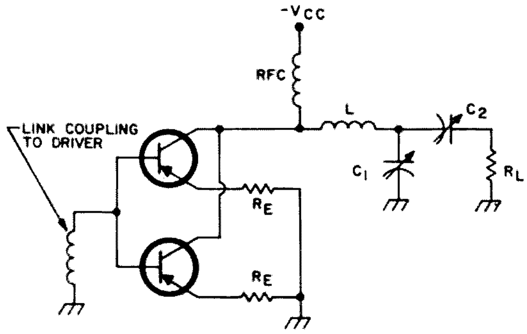


Fig. 4. Two transistors in a parallel configuration.

in the output owing to a higher value of C_O. The same equations as given in the previous design procedures can also be used here. In choosing your transistor, don't forget that the power it should be capable of providing is a little greater than ½ P_f.

Fig. 5 shows two transistors in a push-pull arrangement. Note the similarity to tube circuits. L and C can be found by judicious use of a GDO and the link coupling to the drive should be adjusted for optimum output. Make sure that everything is quite symmetrical to ensure that both transistors receive equal drive.

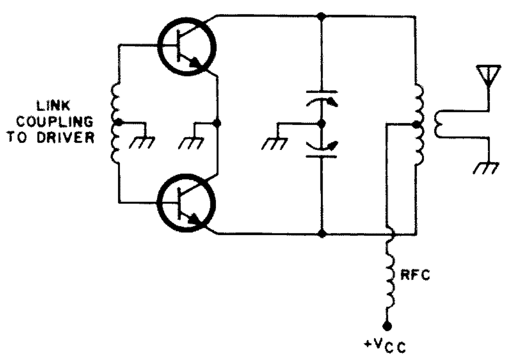


Fig. 5. Two transistors in push-pull arrangement. Make sure both transistors receive equal drive.

The remarks about design equations and power output given for **Fig. 4** above, apply here as well.

Class "C" Operation

Class C operation can be achieved by putting a low value resistor in the emitter or base connections as shown in **Fig. 6 (a)** and **6 (b)**. The drive required is greater

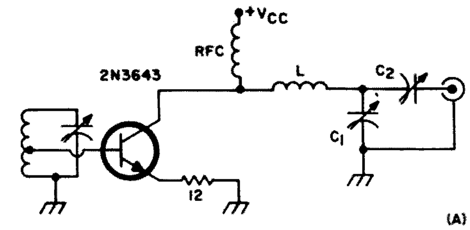


Fig. 6A. Class C operation by putting a low value resistor in the emitter connection.

than that for class B but the efficiency is somewhat greater. The value of the resistor and the drive power are best juggled in practice to achieve best efficiency and output. It appears to be a matter of individual adjustment for each type of transistor. Even different transistors of the same type in the same circuit require individual adjustment for optimum operation. Note that the emitter resistor is in the order of tens of ohms and the base bias resistor in the order of hundreds of ohms.

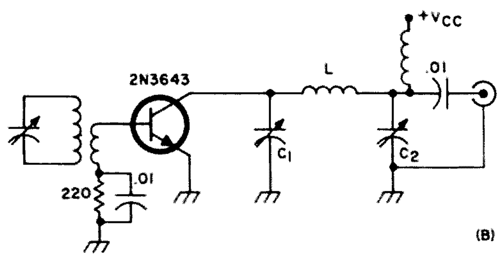


Fig. 6B. A low value resistor in the base connection for Class C operation.

Frequency Multipliers

Frequency multipliers are just another application of a Class C amplifier. The tuned circuit in the collector should be tuned to a frequency two or three times the frequency being injected at the base. I would suggest that a frequency multiplier should not be used as a final owing to the presence of subharmonics in the output.

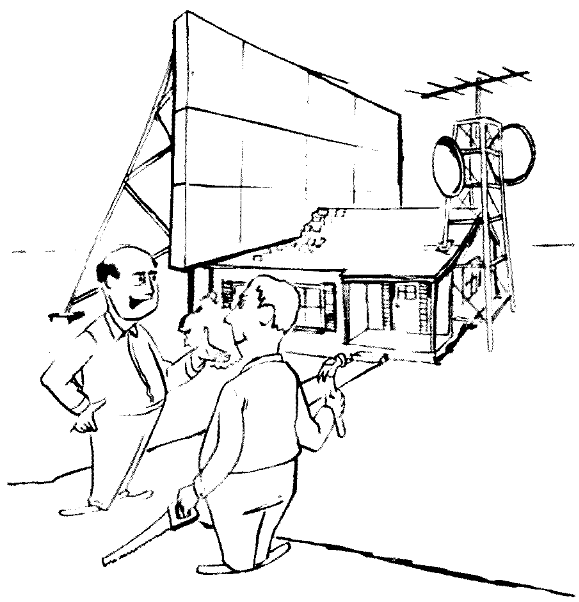
When using a frequency multiplier as a driver, it should be no more than a tripler as it is difficult to get sufficient drive

owing to lowered efficiency. When frequency multiplying, it is probably better and cheaper to use doublers throughout owing to greater efficiency and output.

Conclusion

Think over your next project—can you transistorize it? Don't just "lift" circuits—design them. It's not hard; don't let the equations fool you. Many of them are as simple as Ohm's Law equations. You don't have to own a slide rule or possess a Communications Engineering Diploma. Just sit down and carefully follow the procedure. Check your results, and there's your design. All you have then to do is build it. I hope it works for you.

. . . VK3ZRY

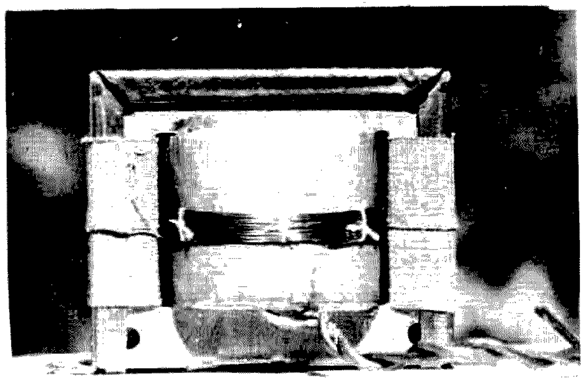


You realize, of course, you've ruined your amateur standing.

Alton Glazier K6ZFV
3154 Jordan Road
Oakland, CA 94602

Two for Mobile

The purpose of this article is to present to the reader the choice of two mobile transistorized power supplies using filament transformers. Having examined a number of articles on the subject, and after hours of bench testing, I have found the circuits which follow offer these basic advantages low price, simplicity, and reliability. The two units described here were made up of materials at hand, and undoubtedly many variations could be used, particularly the transformers and the transistors.



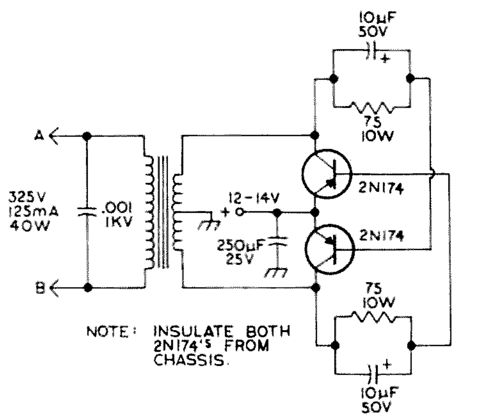


Fig. 1. Mobile power supply schematic with an RC network establishing feedback. This unit is capable of 40 watts output, 525v at 125 ma.

The first unit is capable of better than 40 watts output, 325 volts at 125 Ma. It will be noted in **Fig. 1**. that feedback for oscillation is established by an RC network.

The second unit is capable of 90 watts output, 300 volts at 300 Ma. It will be noted in **Fig. 2**. that a feedback winding has been added to the transformer.

In selecting the transformer, be sure the window is large enough to accommodate the winding. The window is the inside opening of the core. In winding the feedback coil, cut four pieces of plastic tape three inches long, slip the tape (sticky side toward the core) between the core and the coil. Now pull the tape against the core. Do this on both sides. This will protect the enamel covering when you wind the feedback coil. Cut two pieces of No. 24 wire, 48 inches long. Start feeding the wire through the window. Leave about 10 inches for a lead to the transistor base. Next wind five turns, using the second piece of wire. Continue the winding. The two center leads are scraped clear of insulation, twisted together and soldered. This will give you a ten-turn coil with a center tap. Use needle and thread and bind the feedback coil together in several places.

Note: Just tack the feedback leads to the bases of the transistors. These leads may have to be transposed when you first try the power supply. You can tell if it is oscillating by the audio note. If the note is not present, shut off power and transpose leads. In wiring the supply, use at least No. 10 wire from the fuse to the emitter. Use a fuse holder to make

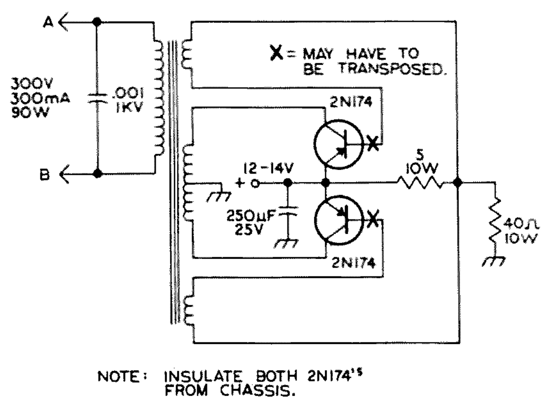
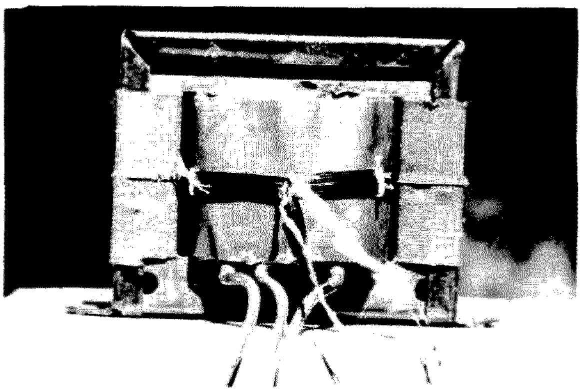


Fig. 2. Schematic of second mobile power supply, delivering 90 watts output, 300v at 300 ma.

positive contact (it is surprising how many do not). If holder heats up during use, replace with a better grade. The wire size from the battery to the relay, and from the relay to the fuse holder should be the largest you can use, and should not be smaller than No. 10. The relay contact should be capable of at least 50% more current handling capability than you would normally use. I prefer to use a double set of contacts wired in parallel.



The frequency of these units is determined by the inductance and capacitance of the transformer, as well as the bias. Naturally, the frequency is lower than a toroidal transformer, and it will be necessary to increase the value of the filter network to take care of the lower frequencies. It was not found necessary to use large heat sinks as such, just the chassis is used for this purpose. Be sure to use silicon grease on both sides of the transistor insulator and mount bias resistors away from the transistors.

The filament transformer used is a Triad F18X, 6.3 volts at 6 Amps. The filter capacitors were from a tv set, also the filter chokes. In the 90 watt unit, use two chokes in parallel. For the purist, use .001, 1kv capacitors and 475 K, ½ watt resistors for spike suppression and voltage equalization across each diode. See Fig. 3.

Both of these units were bench tested, using full power output, with a resistive

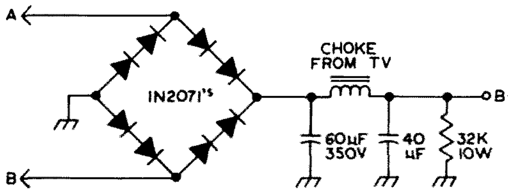


Fig. 3. Filtering method.

load. The tests were conducted for a minimum of one hour.

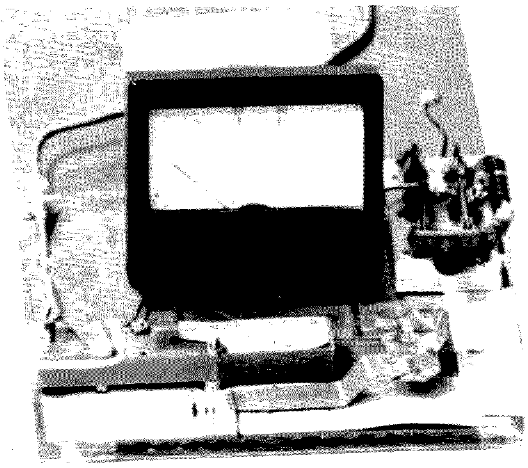
In mounting the power supply, be sure to use the coolest spot possible. The space between the grill and the radiator is excellent. I long ago gave up using the driving compartment, not only due to heat, but the audio note produced after a few minutes becomes quite annoying.

In constructing either unit, use proper mechanical layout. Be sure to mount the bias resistors, bleeder resistor and transformer so that their heat does not add to the heat of the transistors. If you use a chassis for a heat sink, mount the transistors away from each other.

Although the efficiency of these units is not as high as totoidal units, from the standpoint of power input to power output, they do a good reliable job, and until toroidal transformers are readily available, and their cost is lowered, for the amateur who needs one or several mobile power units, these will give years of reliable service under normal conditions.

K6ZFV

Frequency Meter – 1 to 10 ghz Amateur Microwave



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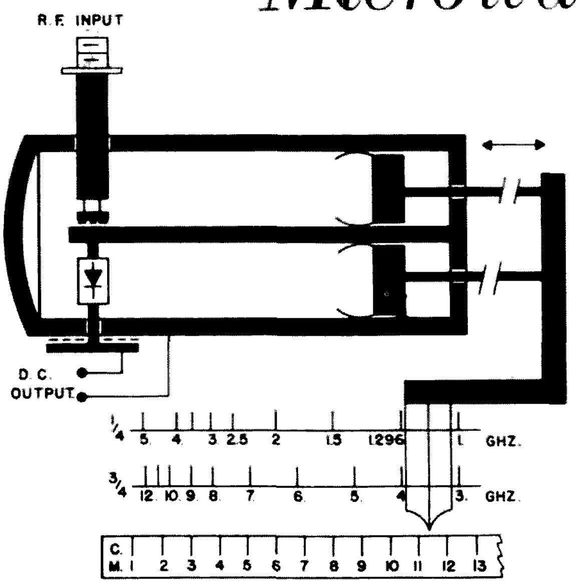

Fig. 1. Coaxial cavity, basic circuit.

Wavemeters from 40 to 1400 mhz have been described in a previous article in *73 Magazine*. This one covers the range from 1,000 mhz up through 10,000 mhz. (1 to 10 ghz)

A quarter wave coaxial cavity is used up to about 5 ghz, and from there to over 10 ghz the three quarter mode is used. A complete explanation of these types of operation is given.

The same type of unit can be used as a very good tuned mixer from 1 to 10 ghz.

The Coaxial Cavity

The basic circuit of the coaxial cavity is shown in **Fig. 1.** A cylindrical outer cavity wall encloses a round rod some 4 inches long which is the center conductor—this center conductor is grounded at one end.

The Shape of the Cavity

The exterior shape of the cavity is shown in **Fig.2.** and is seen to be rectangular in cross section, with two thin walls and two thick side walls. Believe me, this configuration was not arrived at in one day! Designing tuners for X Band, I gaily started in with sections of thin-wall round pipe, the way I'd always done on uhf. The first thing you run up against is, how do you make the diode bypass capacitor? Machine out a cur-

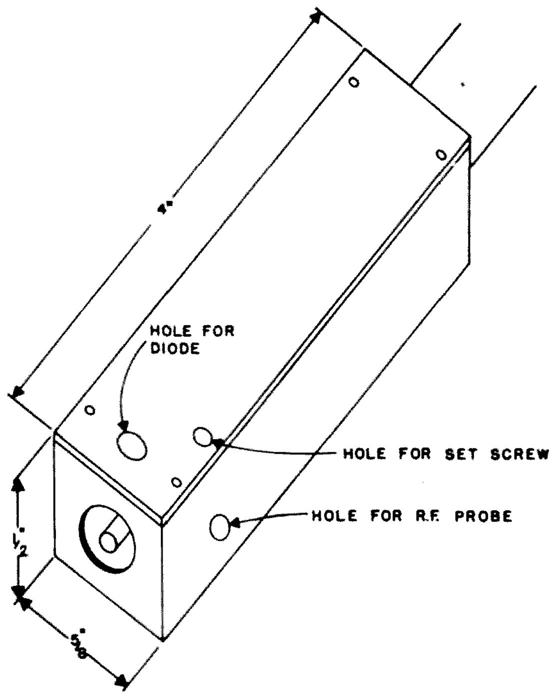

Fig. 2. Shape of the cavity.

ved saddle piece to fit exactly over the outer wall? Possible, but too expensive. And then how do you introduce the rf probe coupling into the cavity? Add on a "saddle" with a hole in it? These considerations and others, such as mounting (more saddles?) led to the

abandonment of the pipe as a shape for microwave cavities; but not until a lot of time had been spent on the above mentioned items.

Diode holder and capacity

Looking at **Fig. 3.** you will see the first answer arrived at; but only after weeks and weeks of making different types and shapes. The center conductor is slightly flattened and drilled out to fit the diode prong. An 8/32 copper machine screw is drilled out to fit the other prong, then slotted with a fine jeweller's saw, and then compressed slightly to an inside diameter a shade less than the OD of the diode prong. In this way the copper screw will hold the diode as you insert it into the cavity. Believe me, that helps!

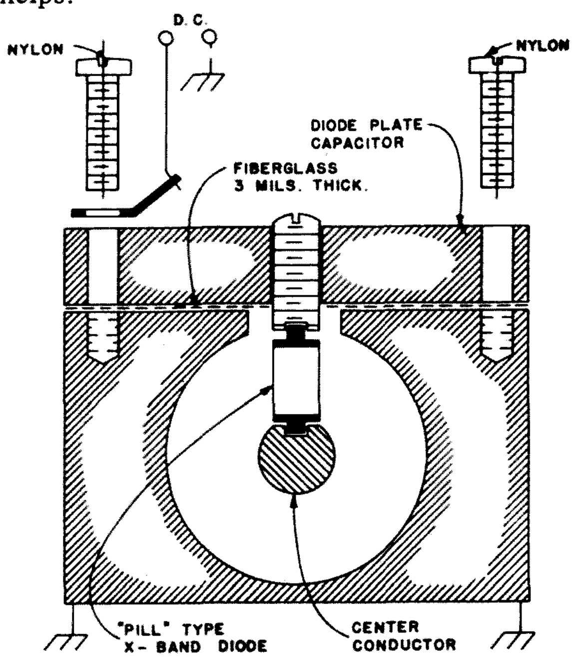

Fig. 3. Diode holder and capacitor.

The second answer is also evident from **Fig. 3.** as the diode bypass capacity can now be made efficient at X-Band. As mentioned before, you cannot "buy" a capacitor "good for X-Band. You can make it though, as shown in **Fig. 3.**, if the cavity body has been designed correctly for it. One of the thin wall sides of the cavity is drilled out (or machined out) just wide enough to clear the diode and it's holder, which is the 8/32 copper screw. The copper capacitor plate, which is thick enough to take at least a half dozen 2/56 threads, is drilled and tapped for the 8/32 screw, and clearance drilled in the corners for the 2/56 mounting screws. A soldering lug for the dc connection is used under one of these, and a three mil (three thousandth of an inch) thick sheet of fiberglass cut out to fit, larger than the plate. This helps to keep metal particles from lodging inside the tiny crack that might be there if the fiberglass sheet did not extend out beyond the plate all the way around. You can begin to see some of the detail needed at X-Band.

The rf probe, input and output connectors

Further reasons for the rectangular cross-section now show up in **Fig. 4.**, which details the rf probe connections. This item was also very troublesome in first models using pipe

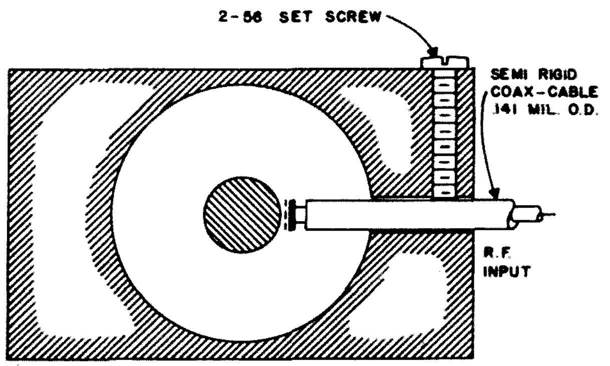

Fig. 4. RF probe connector detail.

walls, where "more saddles" was the only solution. All "saddles" are eliminated by the rectangular shape. Small semi-rigid cable is used for the connector. I have some short lengths with X-Band antennas connected to them for use as "In-Space" pick-ups, feeding directly into the wavemeter cavity. There is at times an advantage in this type of "energy collection" (antennas) which will be taken up later.

Fig. 5. shows detail of the treatment of the cavity end of the rf cable, or probe. The outer conductor is cut away for about one quarter inch in length and removed. About a sixteenth or so of the Teflon is left, which is then removed from the center conductor. A

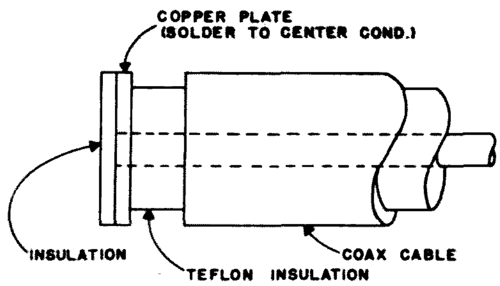

Fig. 5. RF probe detail.

thin copper washer (which I generally cut out of sheet copper since the hole to solder the center conductor is quite small) is then soldered to the center conductor, making the "capacity probe", as shown in **Fig. 5.**

Mylar tape or other good insulation is fastened to the side of this washer facing the center conductor. With this insulation in place you can push the probe all the way in, while testing, and still not have a dead short. Different thicknesses of fiberglass sheet can also be cemented on, to make up more permanent types of fixed capacitors, of different values.

For some uses, particularly in this one as a wavemeter, loose coupling is desired, but it must be securely locked with the set screw, otherwise your dial calibration and frequency reading will suffer.

Plunger fingers

Here is the most difficult item. It is hoped to have stock pieces made up for this work that you can purchase at reasonable cost. The fingers should be made of tempered beryllium-copper, which is not easy to work with.

Fig. 6. shows some details of the plunger and fingers. I assume, having been told so by "well-informed sources" (mechanical engineers) that these units should be made in a machine shop by competent machinists. Maybe so, as the ones I have made here in the shack by hand tend to lose their tension if not handled carefully.

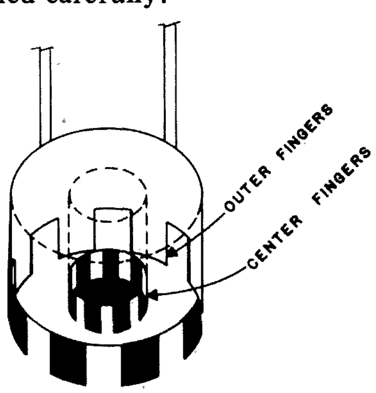

Fig. 6. Plunger details: A)End view, B)Outer fingers, C)Center fingers.

Fig. 7. shows the desired fit for these fingers. The plunger body should be an easily slide-fit *inside* the ¼ inch cavity, and the center hole in the plunger after the fingers should also be an easy fit *over* the center conductor.

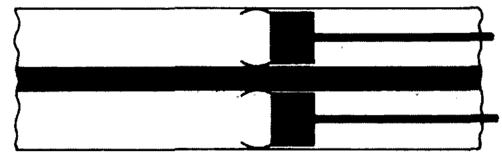

Fig. 7. Desired shape and curvature of the plunger fingers.

Two steel push rods lead back from the plunger through small holes in the back end of the cavity (see **Fig. 1.**); these terminate in the brass block which is furnished with a pointer for the frequency scale. Maximum extension of the plunger should be up against the end piece, as a positive reference point for the dial, in case of trouble after calibration. This point should be indicated on the scale as "minimum frequency" in order to reset the pointer if it should ever become displaced after calibration.

The diode

At present, the diode used is an X-Band "pill package," with a prong at each end as shown in **Fig. 3.** These are point-contact diodes, like the famous 1N23 ceramic cartridge types of World War II fame, only a lot smaller. Referring again to **Fig. 3.** always make sure that the ceramic part of the diode is, as nearly as possible, in the open space between the inner and outer conductors. This space is where the rf is! It is also important to make sure that there is as much metal surface continuity as possible along the cavity wall, across the fiberglass sheet X-Band capacitor insulation onto the diode capacitor plate, and from there over to the diode holder and onto the metal end of the diode.

The rf is at a maximum between the inner and outer conductors, which is an air space of a sixteenth of an inch. and that is where the diode should be.

The diode rf bypass capacitor, formed by the diode plate and the flat top of the cavity body, need only have a capacity which is relatively small; anything over about 20 pF is sufficient. What it *must* have is the proper *lack* of inductance! The details of how this act has been covered in previous paragraphs, and if you follow those details you will find little or no rf on the *outside* of the diode capacity plate or the dc lead from it.

X-Band is not just short waves. It is really short; like a quarter wave at X-Band equals 9/32 of an inch as you can plainly see, if you get one (or more) of those little plastic millimeter rulers in a stationery store for 5 or 10¢. Be sure and get some, by the way, if you're going to do anything above two meters.

Fig. 8. shows the millimeter scale, with s, C, and X-Band plainly showing.

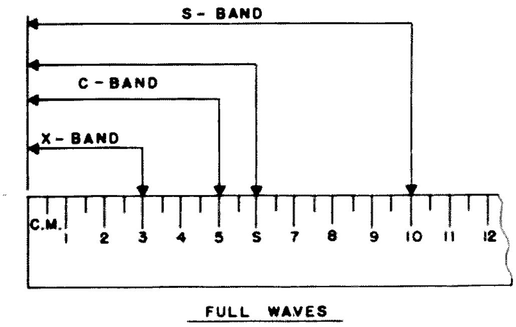

Fig. 8. Full waves for S, C and X-Bands on millimeter scale.

A handy wavelength-frequency chart is included here for your convenience, which is useful from the khz range way up *above* X-Band. See **Fig. 9**. Get to know the easy reciprocals, like 1 centimeter equals 30,000 mhz, 3 centimeters equals X-Band, 10 centimeters equals S-Band (3,000 mhz), 1,000 mhz equals 30 centimeters, etc. Very useful!

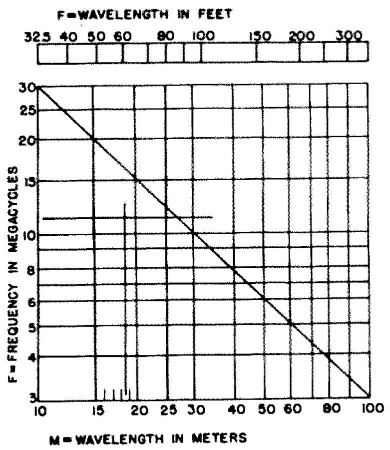

Fig. 9. Wave-length/frequency converter. Use of multiplying factors such as those at the bottom of the graph will cover any portion of the electromagnetic-wave spectrum.

The 3/4 mode and harmonics

Don't worry about that word "mode." Generally when something odd takes place in a cavity or waveguide, certain types of engineers tend to fall back on obscurantism (I seem to have fallen for that $64 word. It just means covering up). They say, "It jumped mode", or, "Spurious showed up."

Here's the straight dope. **Fig. 10** shows the quarter wave "mode" of operation. Starting at 1 ghz you will find *one* point of maximum dc output. If the oscillator under measurement is "running hard" with lots of 2nd and 3rd harmonic energy content, these will be found at 2 and 3 thousand megahertz, and possibly higher ones, which should drop steadily in power as you go up. The diode itself may cause some of these if hit too hard with the rf input.

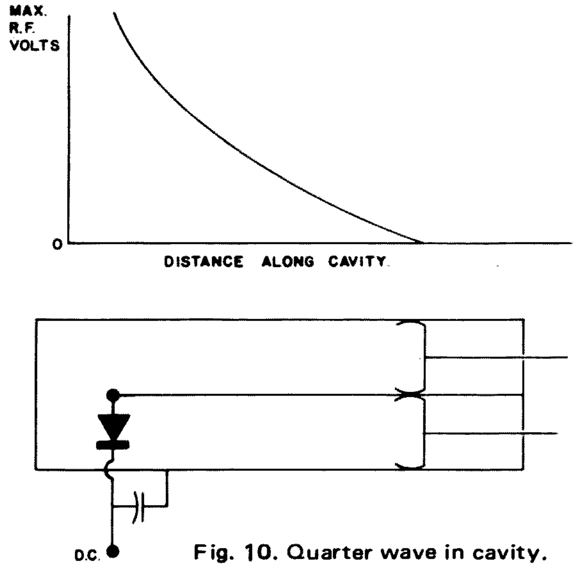

Fig. 10. Quarter wave in cavity.

Fig.11. shows the 3/4 wave mode, which is a very "natural" type of operation. Don't forget that in an instrument of this kind you are looking for standing waves and you want them to be of the greatest amplitude possible (within reason). So, if you tune the cavity by the plunger so that it measures

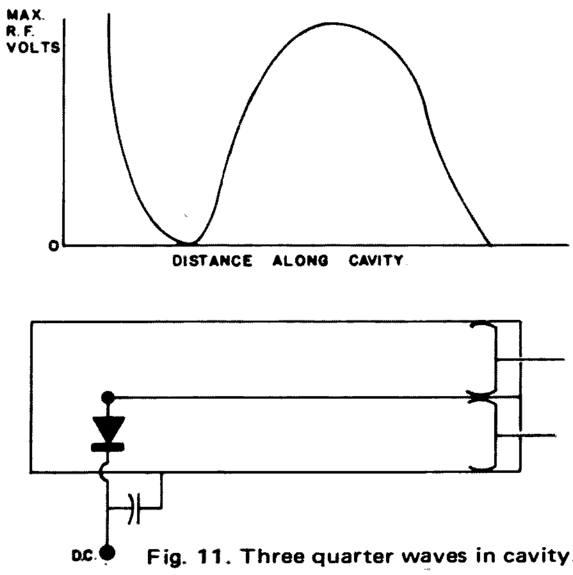

Fig. 11. Three quarter waves in cavity.

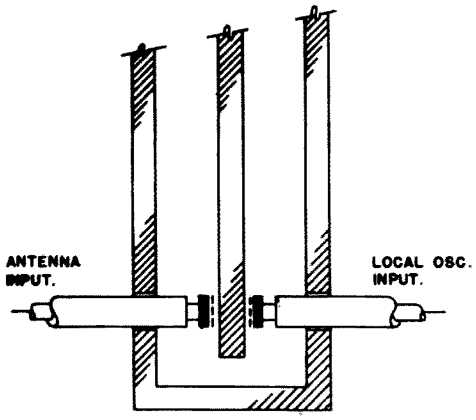

Fig. 12. Double input detail.

some three quarter waves on it (allowing for length-loading of the diode on the first quarter), you will find two peaks on the meter due to the situation shown in Fig.11. The higher the Q, and the lower the losses along the line, the more quarter waves can be found. For the 4 inch cavity shown, three quarter waves at S-Band are the longest that will fit.

A check on this operation is easy. Using the millimeter scale on the "dial', take several readings between maximums, for example, 22, 37, 51, and 67, add the spacings together, which comes to 45 millimeters, divide by three (the number of samples), and you will find an average of 15 millimeters for the waves which are standing on the center conductor (or "along the cavity", if you prefer) and there you are, 15 millimeters for the half wave, 3 centimeters for the full wave. Which is X-Band at 10,000 mhz or 10 ghz.

If you find numbers which are not well known, you can find the frequency on the chart, at least close enough to put you in one of the microwave amateur bands, such as 5,650 or 10,500 mhz.

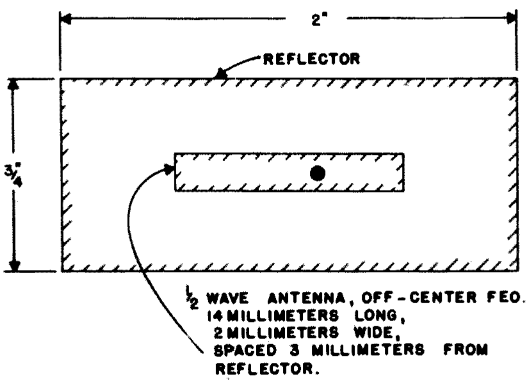

Fig. 13. Test antenna—X-Band "two-element".

Use as a Microwave Mixer

This same type of cavity can be used from 1 to 10 ghz as a mixer for the front end of a superhet receiver covering those frequencies.

This application will only be touched on briefly here as the whole receiver is detailed in another article in *73 Magazine*.

Fig. 12. shows how to do it, so you can plan on this use, and make more than one, if you wish to.

Looking at Fig. 12., you can see how useful it is to have *two* thick sides on the cavity, one for rf input and one for the local oscillator input.

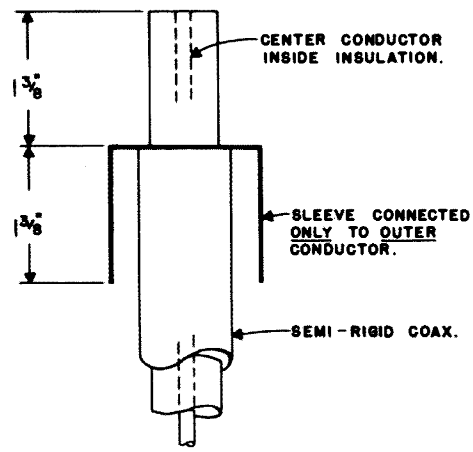

Fig. 14. Test antenna—S-Band. Dimensions suitable for amateur S-Band 2,400 mhz (omni-directional).

Conclusion

That about covers the details and some uses. The whole unit can be mounted on a piece of copper-clad, along with a 50 ma meter, the dial scale, and the centimeter-frequency chart. I broke down on this one and used a "regular" small microwave input connector for the rf. (Instead of an "RCA Phono Jack".) For connections to other units, such as oscillators and multipliers, small flexible cable may be used.

Fig. 10 shows a test antenna for X band, not the best in the world but good enough for a starter. With a lens in front it really picks up signals. Fig. 11 shows an S band antenna for the 2,400 mhz amateur frequencies.

Hope to make arrangements to have this unit (cavity tuners) available for you.

. . . K1CLL

Audio Organizer

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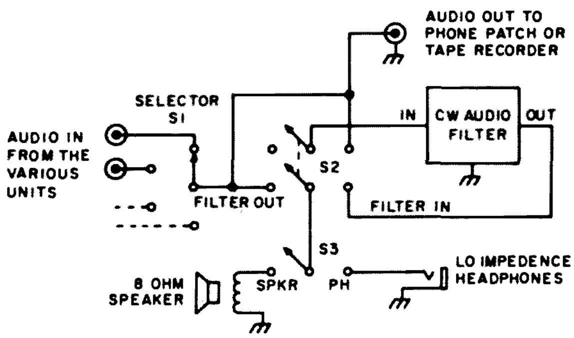
Examine any of the new lines of SSB transceivers. Chances are they require an external loud speaker. And on the less expensive ones, chances are also in favor of the need for an outboard audio filter for CW work. Add to the list of accessories, headphones, phone patches and tape recorder, and on top of this whole mess, more than one rig in the shack! You could have a nightmare switching all this stuff around.

With just a little organization and planning, you can turn all of this chaos into a neat, efficient audio control system flexible enough to fit just about any station situation.

This audio organizer lets you select any number of receivers or transceivers, couple your headphones in without having to fumble with the phone jack, switch your CW filter in and out as needed, plus providing auxiliary outputs for phone patch or tape recorder.

My organizer is built into the same cabinet which houses the speaker, but you can use any convenient box, as long as it is placed within easy reach for operation. All connections are made at the back of the box, so the operating area is kept free from exposed wires.

Selector switch SI is a single-pole multiple contact switch, the number of positions depending on the number of different rigs you want to switch in. For most stations, a four-position switch should



be more than adequate. The remaining switches can be either slide or toggle type. Connectors can be phone jack or phono type, either will work. You can see that this gadget lends itself to junkbox raiding on a grand scale.

Use a good grade loudspeaker, with 4 inches as a minimum size. A baffle made of wood is better than a metal cabinet, but if you do use a metal box, line it with fiberglass or audio damping material, or at least several layers of folded newspaper. This simple acoustic treatment will make the audio quality of your speaker system sound considerably better.

If you do intend to include a CW filter, there have been several articles writen in the past few years on effective, simple to construct units. Some of the more recent ones are: "Filter/ Monitor for the CW Man," Feb. 68 QST p.47; "Added CW Selectivity for Transceivers," Mar. 68 CQ p.32; "A Solid-State Audio Filter," Dec. 68 QST p.35.

....WB2WYO

Converting a CB Transceiver to Six Meters

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This article is a report on a recent project that was undertaken to determine the feasibility of converting a typical eleven-meter citizen's band transceiver to the six meter amateur band. The conversion was done on a Knight C-22 that was obtained in a trade with a local CB'er. The conversion involved considerably more effort than was expected, and is not recommended for the beginner. However, the results were very successful, and this was a very rewarding project.

The C.B. Rig

The transceiver as it was originally, had a transmitter with a single tube, a 6CX8. The triode section operated as an overtone crystal oscillator, driving the other section as a final straight through on 27 mhz. The audio section consisted of a 12AX7 driving a 12AQ5 which acted as both audio output amplifier on receive, and as a modulator on transmit. The receiver had two *if* stages on 1650 khz, both 6HR6's. The converter stage consisted of a 6EA8. The triode section served as local oscillator, and could be switched between either tunable or crystal controlled. The other section of the 6EA8 was the mixer. There was no *rf* amplifier stage in the receiver. A squelch and noise limiter were also included. Power was supplied by a self contained power supply that could be operated from either 115 VAC or 12 vdc.

Converting the Transmitter

The conversion was done in three major parts, the first of which is the transmitter conversion. This was done first because it seemed easiest. Just plug in a six meter crystal after changing the values in the tuned circuits, and it should work. It did work, but this path was eventually doomed to failure. Components and circuits that worked well at eleven meters were inadequate for vhf. Also, overtone crystals that would have to be used are expensive, and often difficult to find. It was finally decided to go to the configuration shown in **Fig. 1**. The old reliable 8 mhz crystal oscillator and tripler circuit was used with the triode section of the tube. The other section was used as a doubler and final amplifier stage. When this circuit was first constructed with the 6CX8, the drive to the final was inadequate for acceptable modulation, and the tube was changed to a 6BA8A. This

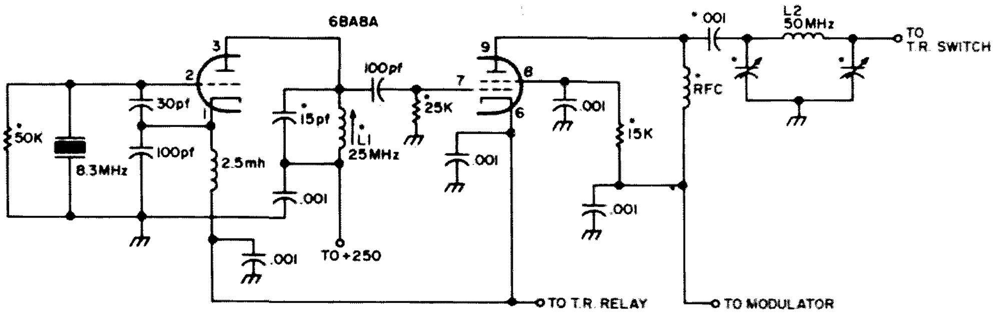
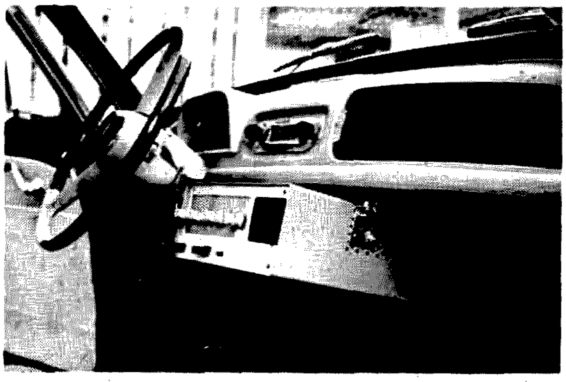


Fig. 1. Transmitter circuit.



tube provided the slight increase in drive that was needed, and good results were finally obtained.

All the original bias resistors were retained, and it is assumed that they are of proper value. The tank coil was rewound with five turns of number 18 wire, ½.. in diameter. The plate blocking capacitor and the *rf* choke as well as the pi net capacitors were left as they were originally, and they work well. Both sections of the tube were connected to the B+, and the cathodes were grounded by a relay to transmit.

The power input to the final stage is about five watts, and the output is about one watt. This is typical performance when a tube is operated as a multiplier stage. More output could have been obtained if another stage were included in the transmitter, but the effort required and the lack of space more than offset the small increase in output that could be obtained.

On the first tests with a short length of solder for an antenna, solid contact was obtained with a mobile station about a mile away. It was decided that a better antenna was needed, and the rig was connected to the 40 meter dipole. This quickly brought a visit from a neighbor, with a TVI complaint. Perhaps it was just the antenna, but one of the characteristics of this type of transmitter is its high TVI to power input ratio. Since this transceiver was intended for a mobile installation, TVI was not considered a serious problem, but if it is to be used as a fixed station near television receivers, precautions should be taken to prevent interference.

The rf Amplifier

The methods used at 27 mhz are often unsatisfactory for vhf work, and to provide added sensitivity and selectivity, an *rf* amplifier must be added to the receiver. An MPF-102 was chosen because of its low cost, simple circuit, and good performance. Power was obtained from the cathode of the 12AQ5 audio output tube, and about 15 volts was obtained. The circuit of Fig. 2 was used. The grounded gate configuration was used in order to avoid the necessity of neutralization. The two diodes, D1 and D2, were placed in the input to protect the transistor if the receiver is near a strong 50 mhz *rf* field that could cause damage. The diodes are of the high speed switching variety, and were obtained from a friend. He argued that the 1N34A diodes used in the Handbook[1] are inadequate for protection of transistorized receivers.

In spite of all these careful precautions, the FET was soldered into the circuit, backwards. No amplification resulted, and the error was discovered. No damage seems to have been done, however, because the stage worked quite well after this error was discovered and corrected.

The MPF-102 works well with any voltage between 9 and 15 volts, and has shown no tendency toward instability. Considering its small size, low cost, good performance and low power consumption, the MPF-102 was a good choice for this application.

The Converter Stage

Here, in the converter, the greatest problem was encountered. At first, the tunable oscillator was padded down to about 24 mhz so the second harmonic could be used for local oscillator injection to the mixer. This worked, but resulted in very poor conversion efficiency, and is not recommended. This was discovered when the grid dip oscillator was left on the table near the receiver.

The GDO sitting a foot away put out a

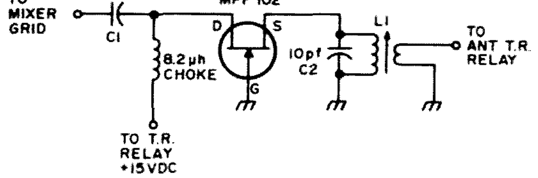


Fig. 2. *RF* amplifier.

L1–9 turns on ¼" diameter iron-slug form with 2 turn link. C1, C2–disc ceramic.

better local oscillator signal than the one in the receiver!

After a great deal of experimentation, the circuit of Fig. 3 evolved. The oscillator circuit is similar to the Handbook$_2$ circuit that was used with an FET. A considerable amount of trouble was experienced with this circuit, and it was finally discovered that the long and sloppy leads used in the CB rig were inadequate for vhf. After the wiring was cleaned up, the oscillator was giving reliable service.

The bottom half of the original oscillator coil was used. The can which shields the oscillator coil should be removed to check terminal connections. This coil consists of seven turns on a ¼" diameter slug tuned form. Actually, a few more turns should be added because this circuit is just barely on frequency with the slug all the way in and all capacitors at maximum capacitance. The component values given may not be optimum, but will work if careful attention is paid to the wiring and layout. NPO disc ceramic or mica capacitors should be used in the tuned circuit to prevent thermally caused frequency drift.

The mixer half of the 6EA8 also gave some trouble. At first, the mixer was oscillating, and the trouble was thought to be the fault of the *rf* amplifier stage. The trouble was traced to an un-bypassed cathode in the mixer, and some other problems were discovered. The screen and cathode resistors were too

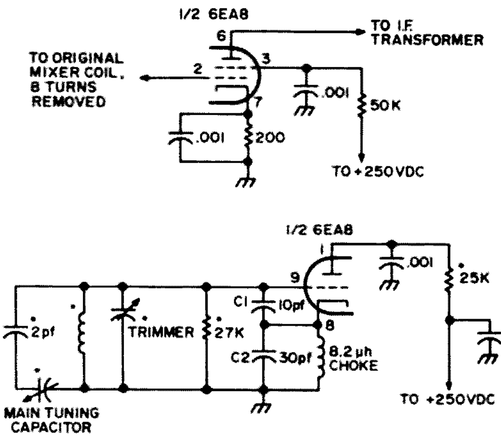


Fig. 3. Converter.

*Indicates original component.
Resistors ½ watt carbon.
C1–NPO or mica.
C2–NPO or mica.
Other fixed capacitors are disc ceramic.

high in value to allow optimum mixer performance, and had to be changed to the values shown in Fig. 3.

After these problems were corrected, the front end of the receiver was tuned up and found to be operating very well.

Switching Considerations

The relay in the transceiver had two double throw contacts and one single throw contact, normally closed. One double throw section switched the B+ for certain parts of the audio stages, and the other double throw contacts ground the transmitter cathodes on transmit, and ground the speaker terminal, connecting the speaker, during reception. The third single throw contact was used to disconnect the receiver from the antenna during receiving. The transmitter was originally permanently connected to the antenna.

This arrangement was considered unsatisfactory, and the following modifications were made. The single throw contact was used to control the voltage to the FET *rf* amplifier. The double throw contacts that switched the speaker and transmitter were used as an antenna change-over switch. Now the transmitter tank circuit is completely disconnected during transmit. Interconnections were made with Amphenol 21-597 Subminax 75 ohm coaxial cable that was in the junk box. RG-174 could also be used, and is a little smaller. Another relay was added to perform the function that was not handled by the original relay. The relay used was obtained from surplus, and was the sensitive type with an 8000 ohm coil. A 50 K ohm resistor was placed in series with the coil, and connected to the 250 volt B+. The other end of the relay was switched to ground by the microphone push to talk switch as was done with the original relay. The relay was mounted under the chassis, and takes up very little room. Also, the power consumption is small.

Final Results

The results from this project showed that a CB to six meter conversion is practical, but more difficult than was expected. If a CB transceiver is available, and there is a desire for a compact six meter transceiver for mobile or portable use, this is an excellent project. The inherent qualities of the CB transceiver with its squelch and noise limiter make it ex-

cellent for mobile use. The transmitter, though low powered, is easy to build, has good audio quality, and provides good short range communication. A comparison with a similar commercial transceiver[3] under mobile conditions showed similar performance on transmitting, and decidedly superior performance receiving. The transceiver, with its small size and built-in power supply is easy to mount, even in a compact car.

The complete conversion took four days of afternoons and evenings, and cost less than five dollars. The more experienced builder could probably do it in a weekend, especially with the help of this article.

So, considering the successful results of this conversion, the technician or vhf enthusiast with a "useless" eleven meter transceiver on his hands should be encouraged to know that a successful conversion is possible, and practical.

...WB6BIH

References

1. Headquarters Staff of the American Radio Relay League, *The Radio Amateur's Handbook*, Newington, Conn. 1968.
2. *The Radio Amateur's Handbook*, page 392.
3. The WRL "Tech-Ceiver 6" TC-6A.

Getting Your Extra Class License

STAFF

Part XI – Oscillators

Some 50 years ago, a revolution hit amateur radio. Up to that time, the spark gap had been king—but about the time hams returned to the air after WWI, a different sound began replacing the roar of King Spark. The continuous-wave oscillator had become available, and its much narrower bandwidth permitted dozens of operators to work in the space required by a single spark transmitter.

It was much the same story as the battles when SSB came onto the scene one and a half wars later, but the revolution toppled King Spark from his throne and today the spark-gap transmitter is illegal. All amateur radio communication makes use of the CW oscillator in some fashion, either as a CW source in itself, as the source of a carrier to be modulated, or as the source of a carrier to be suppressed after sidebands are generated for transmission.

Because the CW oscillator is so fundamental to modern radio communications, the FCC insists that would-be Extra Class operators have an adequate knowledge of oscillator operation and adjustment. In this month's installment, we'll cover five of the Extra Class study list questions which deal directly with oscillators—and also quite a bit about oscillator operation which doesn't appear directly in the study list but which is essential to other questions which do.

The specific study list questions with which we're dealing this time are (numbers, as always, are those assigned by the FCC):

17. How does the positioning of a powdered iron tuning slug affect the frequency of the oscillator it is tuning?
28. What frequency should a crystal oscillator circuit be tuned to for maximum stability?
29. What determines the fundamental operating range of a multivibrator?
31. What factors determine the frequency at which a quartz crystal will oscillate? List some of the advantages of using crystals in amateur equipment.
36. How can the safe power input to a crystal oscillator circuit be determined?

We'll follow our usual custom of re-phasing these five questions from the study list into other, more general, questions, and then examining our broader questions as weil as to any similar ones which may appear on the actual examination.

To start, we must examine oscillator principles in detail. The major question involved in this study, which will be our first broad query, is "What Keeps An Oscillator Going?" Of course, we must also determine what gets it started in the first place, but the important thing about an oscillator is that it *does* keep going, and that's where the details are to be found.

With a base of oscillator theory on which to build, we can then turn our attention to more specific oscillator questions. Most of the FCC questions deal with the use of crystals in oscillators, so let's make our second question simply "Why Use Crystals?" and in the course of getting some answers to this we should wrap up FCC question 31 rather thoroughly. Then we can continue by asking "What Limits The Use of a Crystal Oscillator?" and take care of questions such as numbers 28 and 31.

Not all oscillators use crystals, nor do all of them even produce sine-wave outputs, and we need to look at these lesser-used types as well. To do so, we'll ask "Can The Inductors Be Left Out?", and the answers should take us through not only several types of multivibrators but even some coilless sine-wave oscillator circuits for both rf and af.

Most discussions of oscillators and oscilla-

tor theory fall into one of two broad groupings—either they are overly simplified and so fail to mention many everyday problems to which oscillators are subject (in efforts to avoid any math at all), or they are overly precise and require a knowledge of engineering math (particularly the area of Laplace transforms, poles, and zeroes) to be comprehended. We'll try to steer a middle course. We won't be able to avoid all the math, but we should be able to keep things at least as simple as Ohm's Law. This may lead us into some oversimplifications here and there, but if we can't keep them minor we'll try to flag them out to you so that you will know where any potential trouble spots may lie. Fair enough? Let's get on with the questions.

What Keeps an Oscillator Going? An "oscillator," in its most general sense, is a circuit which produces from dc-only inputs an output which contains an ac component. The output of the oscillator may be ac, or it may be pulsating dc, but in either case it contains an ac component which was not present in any of the input voltages or currents. The purpose of the oscillator is to produce this ac conponent.

In most oscillator circuits we use in ham radio, the ac output is a sine wave or very nearly one, but this isn't necessarily true of all oscillators.

The frequency of the oscillator's output may be anything from subsonic (below 10 hz) audio frequencies to rf in the EHF range; a laser, in fact, is an oscillator which has an output frequency in the visible light region.

But the oscillators we're most interested in right now are those which produce sine-wave rf output in the region from say 250 khz up through 30 mhz; these all work in about the same basic way. All conventional oscillators in this applications area based upon feedback principles; in the UHF region especially, some non-feedback oscillators are used.

Any feedback oscillator can be separated into two main sections for analysis. When this is done, the differences between the many types of oscillator circuits—and the basic similarities of all of them—become more evident. We've done so in Fig. 1.

The two main sections of any oscillator,

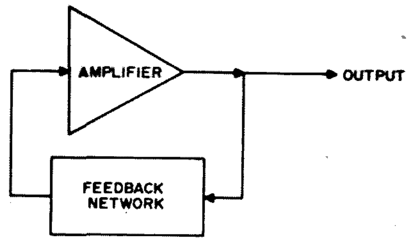


Fig. 1. Basic components of any electronic oscillator are shown here. Amplifier is heart of the circuit, while feedback network takes a part of the amplifier's output back to provide input and thus permit oscillation to continue. If feedback factor times amplifier gain is equal to or greater than 1, circuit can oscillate. Differences among oscillators come about by the many different types of amplifiers which can be used, and the many ways of arranging the feedback network.

as in Fig.1 shows, are the *amplifier* and the *feedback network*. The amplifier part, in itself, is usually a completely conventional amplifier for the frequency range at which the oscillator is to be used. In fact, almost any amplifier can be turned into an oscillator by providing a suitable feedback network—and this feedback network often gets provided by accident, giving us an unwanted self-driving amplifier. Such a situation is known as "spurious oscillation," and is often the subject of much grief. "Parasitics" are another instance of this same principle at work.

We'll get into undesired oscillations and what to do about them in a future installment; this time around we're sticking to desired oscillations.

The feedback network suitable for any particular amplifier circuit in order to turn it into an oscillator depends to a great extent on the amplifier circuit itself. What the feedback network must do is to feed back to the input of the amplifier just enough of the output to provide adequate drive, and do so in the proper phase.

Most conventional amplifier circuits reverse the phase of the signal between grid and plate circuits, and a phase-reversed signal tends to cancel itself out. For such circuits, the feedback network must introduce another phase reversal so that the fed-back signal is in the proper phase to produce the same output signal.

In addition, most conventional amplifier circuits have some gain between input and output; the feedback network must have

corresponding loss, so that just enough signal is fed back to keep things going. Too much feedback will at the minimum produce distortion of the output signal; it may go so far as to prevent steady oscillation.

An oscillator is usually intended to produce an output signal of some single specified frequency. This requires that somewhere in the oscillator there be a tuning circuit to select that frequency and reject all others.

Normally, this tuning circuit is made a part of the feedback network, because most tuning circuits also automatically provide phase-shifting. The phase reversal necessary in the feedback and the frequency selection necessary to restrict output to a single frequency can thus be combined into a single set of elements.

At this stage, we have established the minimum requirements for an oscillator–but we haven't even looked at our main question, "What keeps it going?" Let's start that study by assuming that it is, in fact, already going (then we can find out how it gets started later).

Just to make things definite for our first example, let's select some figures out of the air. Let's assume that our amplifier has an exact 180 degree phase reversal between input and output, and a voltage gain of 10 times. That is, one volt peak-to-peak rf input will produce 10 volts peak-to-peak output in reversed phase.

We won't specify the feedback network right now. Instead, we'll try several different sets of characteristics for the feedback.

With no feedback network in the circuit, we have simply an amplifier. When the input is removed, the output disappears also.

Let's try a feedback network which feeds back 1/100 of its own input (which is the amplifier's output), and leaves phase unchanged. Now our 1-volt input will produce 10 volts output, but 1/100 of this 10-volt output, or 1/10 volt, will be put back into the input. Its phase is reversed from the original input, so it cancels out 1/10 volt of input and leaves 9/10 volt available for the amplifier. This, in turn, cuts the output down to 9 volts–and so reduces the feedback voltage to 9/100 of a volt. This action increases the available amplifier input voltage from 0.9 volt to 0.91 volt. The round-robin action finally settles down when the output becomes 9.1919191919 . . . volts, because when 1/100 of this is fed back the input available for the amplifier is 0.9191919191... volts. The amplifier itself still has a gain of 10, but the effect of the feedback network was to reduce the effective gain to 9.1919.

If we put in a feedback network which feeds back 1/10 of its own input, in the same phase, then a 1-volt input signal will produce 10 volts out (originally) and 1 volt in reverse phase from the feedback which cancels out the original input. With the input gone, there is no output to feed back. The resulting round-robin action finally settles down when amplifier output is 5 volts. Feedback then is 0.5 volts, which cancels out half the original input and lets the remaining half be amplified ten times to produce the 5-volt output.

If all of the output is fed back (a feedback factor of 100%) without phase change, the effective amplifier gain will be reduced to something less than 1. In our example, the gain will drop to 10/11. A 1-volt input signal will then produce 10/11 volt output. This will be fed back to cancel most of the input; only 1/11 volt of input will not be cancelled. The amplifier will boost this by ten times, providing the 10/11 volt output.

All of these examples so far left the phase of the feedback voltage unchanged, which with our specified amplifier meant that the feedback voltage was out of phase with the input. Such feedback is known as negative feedback, and is used to improve amplifier action (as examined in some detail in our Advanced Class study course).

If we use a different feedback network and change the phase of the feedback voltage so that it is IN phase with the original input, things come out differently.

Feeding back 1/100 of the output as we did in our first example, but with phase reversal included in the feedback network, we find that a 1-volt input gives us a 10-volt output, which produces 1/10 volt of feedback. This increases our effective input to 1.1 volts, giving us 11 volts output and increasing the feedback to 0.11 volt. The

effective input rises a little more, to 1.11 volts; the feedback rises with it to 0.111 volt. Each pass around the feedback loop brings the effective input voltage up just a little bit more—but even an infinite number of passes can never bring the output any higher than 1.111112 volts, because each pass merely adds 1/10 of the previous input. The effective gain of this arrangement levels out, then, at 11.111111111..... times.

Let's see what happens if we bring the feedback percentage from 1 up to 9%. A 1-volt input gives us 10 volts out the first time, and we feed back 9/100 of this to bring the input up to an effective 1.9 volts. Output rises to 19 volts. Feedback rises to 1.71 volts, which adds to the previous 1-volt input to give an effective input of 2.71 volts and an output of 27.1 volts. Feedback comes up to 2.439 volts, and output consequently climbs to 34.39 volts.

It might appear that output in this case would climb forever, but it doesn't. When the output has climbed to 100 volts exactly, the resulting feedback voltage is 9/100 of that or 9 volts. Added to the original 1-volt input, this gives 10 volts effective input, and the amplifier's original gain of 10 boosts this to the 100 volt output level.

What happens if we make the feedback percentage 10% now? Let's assume that the amplifier was producing a 10-volt output signal with no feedback, and we suddenly connect a 10-percent feedback network to it. The feedback voltage becomes 1/10 of 10, or 1 volt. If the 1-volt input signal is still present, this will give us 2 volts effective input and a 20-volt output. The next pass around the feedback loop will have 2 volts feedback and 1 of input for 3 volts in and 30 volts out; the next after that will bring us up to 40 volts out, and so forth. The rise in output will never stop because of running out of feedback; the only limit is that imposed by the available power-supply voltage swings. And if we remove the 1-volt input signal at any time after the feedback loop is connected, what happens? If we're getting 20 volts out then instead of rising to 30 volts next time around the loop the output would remain steady at 20 volts, because the 2 volts fed back would provide a 2-volt input signal.

If we had been getting the 10 volts out when the input signal was removed, then we would hold steady at 10 volts output, because 1 volt would be fed back and this would keep output constant.

In fact, no matter *what* output we were getting when the input signal disappeared, we would hold steady at that level, because the feedback factor is just right to give the amplifier an artificial input signal developed from its own output signal. We now have an oscillator.

Notice that this happened with a feedback factor of 10% and an amplifier gain of 10 times. Had the amplifier gain been 100, a feedback factor of 1% would have been enough to do the job. What is required is enough feedback so that the feedback fraction times the amplifier gain is equal to 1. If the signal fed back is in phase with the input signal, and feedback fraction times gain equals 1, the circuit will oscillate.

In practice, of course, the gain of the amplifier may vary as tubes or transistors age, resistors change value, and power supply voltages change with load. Any time the product of feedback fraction times gain drops below 1, the oscillator cannot keep going. However, the product can be greater than 1, and most oscillator designs make it slightly greater just to give a safety factor.

If the feedback is greater than the minimum required for oscillation, output will not be steady at some accidental level. Instead, it will climb to the point at which available power-supply voltage or some other factor limits it, and level off there. For this reason, the amplifier portions of most rf oscillators operate in Class C, with current flowing only during parts of the cycle.

This fact, in itself, introduces some new problems into the action of keeping the oscillator going. When the amplifier works only a part of the time, as is always true in Class C operation, then something must provide a "flywheel" effect to carry the circuit through those portions of the cycle in which the amplifier is effectively "dead." The same resonant circuit used for tuning the oscillator usually provides the "flywheel" by storing energy in its fields and releasing it a fraction of a cycle later.

The resonant circuit is not necessary, though, so long as *some* energy storage capability is included. The multivibrator, for instance, stores its "flywheel" energy in the coupling capacitors. A crystal oscillator uses the crystal itself for energy storage, by converting electrical energy into mechanical energy and back again. We'll get into these a little later, however. To keep things relatively simple at this stage, let's concentrate on the types of oscillators which store their energy in resonant circuits.

In previous installments of this study course we have examined the idea of "Q," the "quality factor" of any energy-storage element, at some length. Since an oscillator operating in the Class C condition requires some type of energy storage within its circuit in order to keep going, we might guess that the Q of that energy storage (in the present case, of the oscillator's resonant circuit) is of some interest to us. And that quess would be correct.

One of the ways in which Q is defined is as the ratio of energy stored per cycle to energy dissipated per cycle. This definition tells us that a circuit with a Q of 1 must dissipate all the energy it stores; such a low Q is usually avoided, and that's why. A storage device which dissipates everything you attempt to store in it doesn't do much towards keeping the energy around for future use.

Any energy taken out of the resonant circuit for any reason is lost so far as the circuit is concerned, and in the definition of Q just quoted, the energy deliberately taken out is included in the energy "dissipated." Thus the Q of a working circuit is affected by the degree to which the circuit is loaded; the heavier the loading the more energy is taken out per cycle, and the lower will be the Q.

The resonant circuit of an oscillator must have reasonable high Q in order for the oscillator to operate; this requirement comes directly from the fact that the resonant circuit is storing the energy to provide a flywheel effect, and the circuit Q serves the same purpose as does the high mass of a mechanical flywheel.

If circuit Q is too low, the circuit may fail to oscillate despite all connections being correct; this is frequently a rather perplexing

problem to a homebrew artist who has modified a "borrowed" design to operate at some new frequency range, and tuned the circuit to resonance by using a dipper without considering the Q which may be required to keep things going.

Q may be increased in either of two ways. The circuit may be less heavily loaded, so that less power is taken out, or the capacitance of the circuit may be increased (and its inductance decreased to match, to maintain the proper frequency). Increasing the capacitance is preferable.

Should this fail to solve the problem, it may be that the circuit is simply not providing enough drive to its amplifier portion. In this case, the remedy is to increase drive by increasing the amount of feedback. The technique for increasing feedback will vary with the particular circuit; in general, the idea is to couple more of the output back to the input.

In many cases, both remedies are applied simultaneously. Increasing the feedback often permits a decrease in loading of the resonant circuit (achieved by reducing coupling between the resonant circuit and the amplifier input, as by using smaller coupling capacitors), which increases the effective working Q.

One of the most frequent causes for oscillators turning balky is the effort to obtain maximum output power. An oscillator, whether crystal or variable, is intended only to establish frequency. Once the frequency is established, its power level can be amplified as much as you like by ordinary amplifiers. If oscillators are not expected to furnish power, they usually behave beautifully.

Before we move on to take a look at crystals, let's see what starts an oscillator.

Remember, so far we have assumed that it was already going, and have looked only at the mechanisms which keep it going once started. However, it's obvious that any practical oscillator does not run all the time. When power is turned on, it has to start. How does this happen?

We make it happen, by using grid-leak bias rather than fixed bias on the oscillator. This assures us that when we turn the power on, the amplifier portion of the oscillator

will (at least in the first few instants) be operating without bias, and so will be able to amplify signals.

When we turn on the power, this act in itself puts a pulsed signal into the power lines to the amplifier stage as the power supply voltage comes up from zero to its operating value. This signal pulse causes the resonant circuit to "ring." Even without the pulse caused by power turn-on, an amplifier always has some random noise in it, and this too is amplifier. Any noise pulses which happen to be near the frequency to which the resonant circuit is tuned will also cause ringing, so that we can always count on at least a little bit of action in the resonant circuit.

As the amplifier stage warms up and comes to life, any ringing in the resonant circuit provides it a small amount of input, and this input is amplified. Since (for safety) we included a little more feedback than was absolutely necessary, the fed-back portion of this amplified input is larger than was the original input level. It continues to build up in this manner, until the amplifier begins to draw grid current. At this point, the grid current establishes a bias voltage across the grid leak and sets up the operating bias voltage. Amplification continues, but the oscillator is running now. When the signal is limited by the available supply power, full Class C operation of the amplifier part of the circuit is going on.

While all this is happening, the frequency of the signal changes. Once stable operating conditions are reached, the frequency settles down. The change in frequency during the start and stop portions of the oscillator's operation cannot be avoided; some of it comes from actual physical changes in circuit elements such as expansion due to heating from the rf current flowing, and some is more exotic in origin–it comes from the change in phase of signal through the amplifier as operating voltages are changed.

Even those most stable of practical oscillators, the crystal circuits, are not immune to these changes. But crystal oscillators are, in themselves, the subject of a different question. Let's move on to that one.

Why Use Crystals? The vast majority of amateur transmitters, and an appreciable fraction of the receivers as well these days, make use of at least one crystal-controlled oscillator in some stage. Our question now is simple–why?

Most of us probably know, of course, that the crystal controlled oscillator is normally much more stable than a variable widely used whenever accurate and stable control of frequency is desired. But why should this be so?

To begin our look at the reasons why, let's back way, way off for a moment and observe that virtually everything we do with electronics depends to a pretty large degree on geometrical relationships among physical objects. A vacuum tube, for instance, gets its amplification because of the ratio in spacing and in area of the grid structure and the plate. A capacitor's capability to store energy is determined by the area of its plates and the spacing between them, as well as by the "dielectric constant" of the insulating material (which is, itself, determined by the molecular geometry of the material). An inductor's inductance is determined by diameter, spacing, and number of turns, all of which are physical quantities. The list goes on, and includes almost all of our components.

What's more, when we make use of the *electronic* results of these physical relationships, many relatively small physical changes introduce large changes in the results. The movement of a metal diaphragm changes the resistance of carbon grains enough to make the carbon microphone practical, but this movement is so slight that you can't see it with the naked eye.

The crystal oscillator gets its frequency stability primarily from the fact that it uses *physical* resonance rather than *electrical* resonance. This eliminates one whole level of relationships from physical to electrical and back again.

The material most often used for frequency-controlling crystals is quartz. Crystalline quartz shares with many other substances an interesting property known as "piezoelectricity," which means that it is capable of producing electricity in response to physical pressure, and conversely of changing its shape under the influence of electrical pressure; of all the piezoelectric

substances, quartz crystals are the most durable and because of this have come into wide use.

When an alternating voltage is applied across the proper faces of a quartz crystal, the crystal will vibrate. The frequency at which the vibration occurs depends only upon the dimensions of the crystal. If the applied ac voltage happens to be at a frequency at which the crystal is mechanically resonant, though, the exchange of energy between the electrical and mechanical stages (and back again) is extremely efficient and very little energy is dissipated within the crystal.

This small energy dissipation means that the Q factor of a crystal (we'll quit pointing out that we really mean "quartz crystal" every time from here on) is high. Astronomical might be a better word. Typical Q figures for crystals range from 10,000 to 100,000; a *good* LC resonant circuit might reach a Q of 500 with extreme care in design and generous amounts of luck.

The natural form of crystalline quartz is a six-sided prism, looking something like **Fig. 2**. If we slice it straight through the middle and look at it end-on, we will find a hexagonal shape like **Fig. 3**. If we then join the midpoints of each pair of opposite flat sides with lines (Y1, Y2, and Y3 in **Fig. 3**) and the vertices at which the sides meet with other lines (XI, X2; and X3), we can establish three pairs of axes (axises, if you prefer); a third axis is provided by the crystal's center line where all the other axes meet, and it is called the "Z axis." These X, Y, and Z axes are established to guide the cutting of the "mother crystal" into blanks having the desired electrical properties. If a blank is cut so that it is perpendicular to the X-axis, it is known as an "X-cut" crystal, and similarly a Y-cut blank is one perpendicular to any one of the three Y axes. At

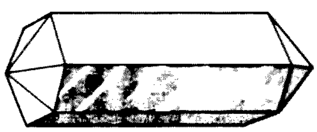


Fig. 2. Ideal quartz crystal is six-sided prism. Most natural crystals are imperfect, with chipped or broken edges or ends. Illustration shows an ideal crystal. Z-axis of the crystal is the line through the center of the crystal, the long way; in this one it would pass through the point at each end.

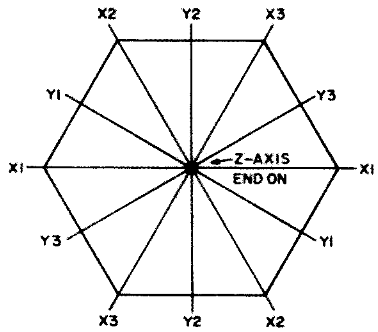


Fig. 3. Slicing the ideal quartz crystal of Fig. 2 across would give this hexagonal cross-section. Z-axis now is vertical to the illustration, protruding straight up from center of section. The six lines joining side midpoints (Y1, Y2, and Y3) and side corners (X1, X2, and X3) show the X and Y axes of the crystal. All the X axes are alike, and all the Y axes are alike, but blanks cut with X-axis orientation differ greatly from those cut across the Y-axis. Most crystal blanks are cut at an angle to all three axes to obtain the desired characteristics. Fig. 4 lists the "standard" cuts by common name and military designation.

least 11 "standard" cuts exist, and today neither the plain X-cut, Y-cut, nor Z-cut is considered standard. Fig. 4 lists the 11 cuts designated as "standard" for military use; the differences between them are all caused by the different angle made between the plane of the crystal blank and the major axes of the original natural crystal.

As listed in Fig. 4, the crystal can vibrate in any of five modes depending upon its cut. Actually, a surprising number of crystals cut to vibrate in one mode will vibrate in not only the design mode but several others, and many will vibrate at a number of different frequencies. This fact is used in the design of "overtone" crystal oscillators, which are designed to operate at some vibration mode

COMMON DESIGNATION	VIBRATION MODE	MILITARY DESIGNATION
AT CUT	THICKNESS SHEAR	A ELEMENT
BT CUT	THICKNESS SHEAR	B ELEMENT
CT CUT	FACE SHEAR	C ELEMENT
DT CUT	FACE SHEAR	D ELEMENT
+5° X CUT	EXTENSIONAL	E ELEMENT
-18° X CUT	EXTENSIONAL	F ELEMENT
GT CUT	EXTENSIONAL	G ELEMENT
+5° X CUT	L-W FLEXURE	H ELEMENT
DUPLEX	L-T FLEXURE	J ELEMENT
MT CUT	EXTENSIONAL	M ELEMENT
NT CUT	L-W FLEXURE	N ELEMENT

Fig. 4. Designations of various types of crystal cuts. Military designation is the type number placed on crystal elements for military use. Vibration modes are shown in Fig. 5.

other than the lowest-frequency mode inherent in the crystal's dimensions.

While the crystal's dimensions determine its operating frequency, it's not always the "thickness" dimension which turns out to be critical. Only the types which operate in the thickness-shear mode (Fig. 5 shows the five vibration modes) are controlled primarily by thickness. The other cuts are influenced more heavily by the width or length of the crystal.

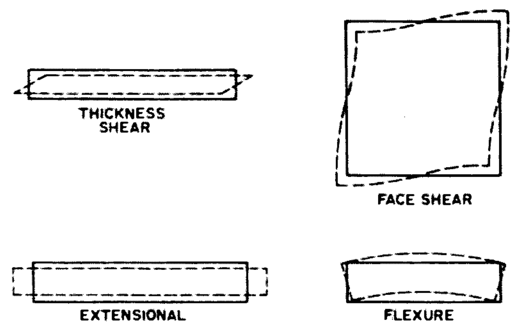


Fig. 5. Quartz crystals have several different "modes" of vibration, and the same crystal may be capable of vibrating in any of several modes (although manufacturers attempt to prevent this by grinding the crystal blank in such a way as to favor one mode to the exclusion of any others). In these drawings, the solid-line view shows the crystal's shape at rest, and the dotted lines indicate the shape at one extreme of vibration in the applicable mode. While most discussions of crystals action tend to leave the impression that vibration is in flexure mode, most common crystals actually use either thickness or face shear mode.

However, alteration of *any* dimension will change the resonant frequency to some degree. So, also, will changing the mass of the crystal; this can be achieved by "loading" the crystal surface with pencil lead or by rubbing solder into the surface. Plated crystals are adjusted to frequency by controlling the thickness (and so the mass) of the plated-on electrodes.

Once the basic vibration frequencies of a blank are established by grinding or etching to final dimensions, and proper precautions against excitation of the unwanted modes are built in so that only one of the several possible frequencies is used, the crystal is ready for use in an oscillator. There, it replaces the resonant circuit as both the

frequency-determining element and the energy-storage device. Most variable or LC oscillator circuits have their crystal counterparts, which we will examine later.

At the moment, though, we're still looking at the reasons for the extreme frequency stability of the crystal. Its astronomical Q is the primary reason, and the relative freedom from effects of the surrounding environment is a strong supporting cause.

The crystal, however, is not a primary frequency standard. It can lose its stability, especially if mistreated. The more its motion during a cycle, the less stable it is. The greater the ac current through the crystal, the greater will be the motion. The higher the feedback fraction, the more current can flow. Thus excessive feedback can produce frequency instability. It can also do other things we'll look at during our next question.

Since the crystal operates with mechanical resonance and physical vibration, but converts the physical vibration into electrical signals, it acts just as if it were an exceptionally high quality resonant circuit. **Fig. 6** shows the schematic of the equivalent circuit of a crystal; the values are those typical for a 7 mhz AT-cut fundamental crystal approximately 1/10 inch thick and 3/8 inch square, which includes a Q of approximately 25,000.

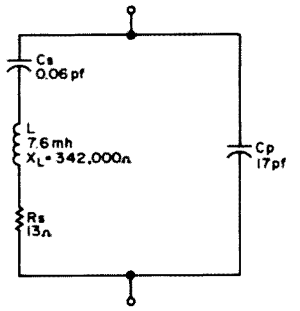


Fig. 6. Equivalent circuit of a typical 7 mhz quartz crystal 1/10 inch thick and 3/8 inch square. All quartz crystals show the same electrical characteristics, but the values given here apply only to the particular crystal element for which they were calculated. Note extremely large equivalent inductance and small series capacitance; large shunt capacitance helps account for stability, since several picofarads additional stray capacitance will have relatively little effect. Q of circuit equals inductive reactance divided by series resistance, or in this case 342000/13 which works out to a little more than 26,000.

What Limits The Use of a Crystal Oscillator? The extreme utility of the crystal oscillator is proven by its wide use. SSB transmitters use them to provide the original carriers, vhf transmitters employ them for frequency control, many mobile rigs are rockbound, and not a few receivers make use of crystal-controlled front ends together with variable intermediate-frequency tuning to obtain top performance. But the crystal oscillator does have limitations; what are they?

Foremost of the limitations is the relatively low power capability of a crystal oscillator. So long as the oscillator is used only to establish frequency, and power generation is left to other parts of the equipment, this causes no problems. But when the maximum of power is required from the minimum of stages, the power limitation may rear its many-fanged jaws.

This limitation stems directly from the inherent fragility of any crystal. Just as Caruso was able to shatter a wine-glass by singing a sustained note at the glass's resonant frequency, so will the quartz crystal shatter if driven hard enough at its own resonant frequency. The excessive drive causes the crystal to bend farther than its strength will permit, and the result is a fractured frequency-controller.

Long before actual destruction of the crystal occurs, though, the stability of the oscillator will disappear. An overdriven crystal heats internally, and the heat causes the dimensions to change. Although the change is microscopic, it's enough to move the frequency several dozen cycles per megacycle.

A crystal which has been abused in this manner may not return to its original frequency for several hours or even several days after the drive has been reduced, either. Occasionally, the change in frequency is permanent.

The preventive, of course, is to keep crystal current as low as possible while assuring active oscillation. Crystal current is controlled by feedback; the less feedback, the lower the crystal current. For maximum stability, feedback should be just great enough to assure that the oscillator starts every time. In the grid-plate circuit, feedback is controlled by capacitor C1. In other circuits, it may be necessary to modify other circuit constants such as plate voltage to control feedback.

Crystal current may be measured by connecting a low-current pilot bulb, such as a 60 ma 2-volt bulb, in series with the crystal. Most crystals, except for fragile high-frequency fundamental blanks, can withstand 60 ma for short periods of time, and so the bulb serves double duty as both current indicator and fuse. The objective should be to keep the bulb as dim as possible while maintaining reliable starting characteristics on the oscillator.

Most crystal oscillator circuits in use today are of the electron-coupled variety, making use of a pentode tube in which the screen grid serves as the virtual plate of a triode tube in the oscillator circuit. This permits the actual output to be taken from the pentode plate circuit with minimum loading of the oscillator itself, and also permits the plate circuit to be tuned to the crystal frequency with the least possible effect upon the oscillator's action.

If electron coupling is not used, tuning the plate circuit to the exact frequency of the crystal may prevent oscillation, by shifting phase of the feedback current far enough away from 180° so that the feedback fraction times gain, at the frequency where 180° phase shift is present, is less than 1. In such cases the plate circuit must be turned slightly off-frequency for reliable, stable operation. Most often, the plate circuit should be tuned to a frequency *above* that of the crystal. Feedback voltage (and crystal current) in such a case will vary with plate tuning, and the adjustment should be made to a point which provides the minimum amount of crystal current necessary to provide reliable starting. This will provide maximum frequency stability.

Can The Inductors Be Left Out? All of the oscillators we've examined so far in this installment make use of a resonant circuit (either LC or the physical equivalent, a crystal) for frequency control and energy storage. However, the resonant circuit is not absolutely necessary.

The most popular type of high-performance audio oscillator, for example,

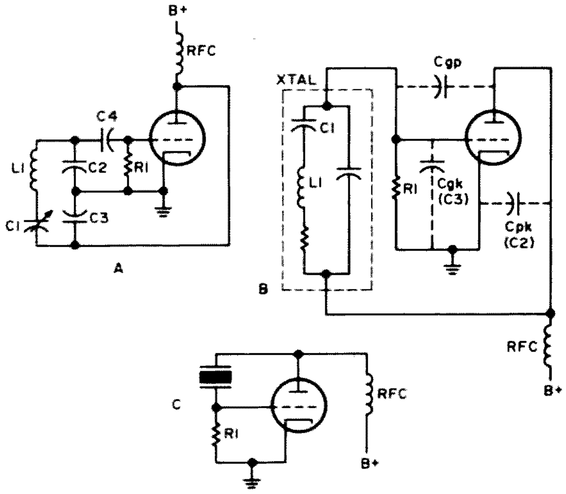


Fig. 7. Equivalence between non-crystal Clapp oscillator circuit (A) and Pierce crystal oscillator circuit (C) is shown here. By substituting the crystal's equivalent circuit from Fig. 6, as at B, we find that two circuits are almost identical. Grid-cathode capacitance of tube serves as feedback capacitor C2, while plate-cathode capacitance provides equivalent of C3. C4 is not necessary in either circuit. Crystal's shunt capacitance merely bypasses the resonant circuit slightly. Crystal's series resistance is also present in coil at A, although it is not shown, since any coil has at least some resistance present.

As shown in **Fig. 7**, we can replace the resonant circuit in a Clapp LC oscillator (**Fig. 7A**) with a crystal, and we have the Pierce circuit (**Fig. 7C**). Similarly, we can develop the grid-plate crystal circuit (**Fig. 8A**) from the Colpitts (**Fig. 8B**).

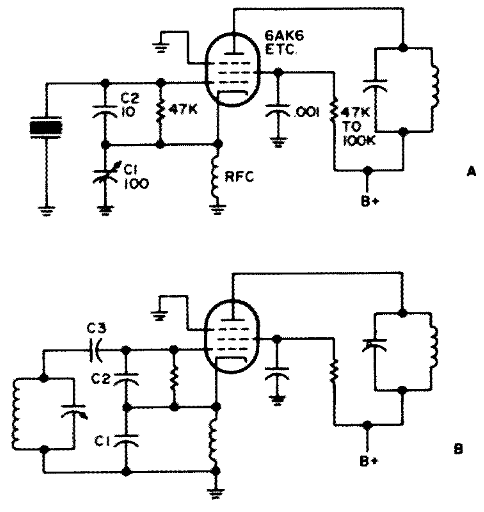


Fig. 8. Similarities between grid-plate crystal oscillator circuit (A) and Colpitts vfo circuit (B) are even more evident than are those shown in Fig. 7. Crystal in this case substitutes directly for resonant circuit, with no need for a dc blocking capacitor (C3 in B). Values shown in A are typical; similar values may be used in circuit at B but care must be taken to assure that resonant circuit Q is great enough to permit oscillation.

In both the Pierce and the grid-plate crystal oscillator circuits, the crystal serves as a parallel resonant circuit. However, as may be seen from **Fig. 6**, every crystal has both a series resonance and a parallel resonance near its fundamental frequency, and some oscillator circuits are designed to make use of the series resonance although most of the popular circuits use the parallel-resonant mode.

In a series-resonance crystal oscillator circuit, the crystal is connected as a series element in the feedback circuit. Most such circuits require more components than parallel-resonant oscillators, as well as requiring tuning of additional circuits (since the series resonance does not lend itself to providing the necessary energy-storage capability). **Fig. 9** shows the Butler overtone oscillator circuit, which is one of the most popular series-resonance oscillators. This circuit uses either the fundamental, third, fifth, seventh, or ninth overtone of the crystal, depending upon the tuning of the parallel-resonant circuits in the plate circuits. Using a crystal ground especially for 7th-overtone operation in this circuit, it is possible to produce direct output at 144 mhz without frequency multipliers.

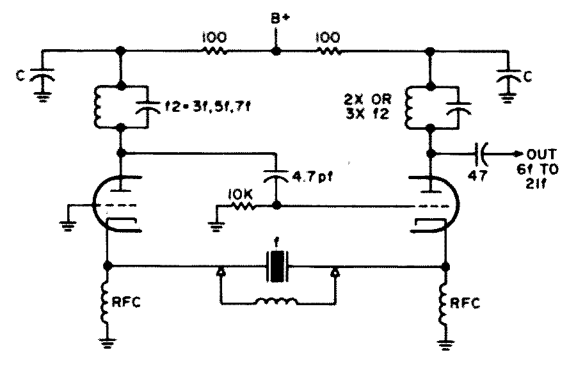


Fig. 9. Butler overtone oscillator circuit makes use of crystal's series resonance in feedback path. In consequence, additional resonant circuit is needed for energy storage. Stage at left acts as grounded-grid amplifier, with its output coupled to cathode-follower stage at right. Crystal in signal path from cathode-follower output to grounded-grid input filters out any signals except those which excite series-resonant vibration capacitance of crystal and holder to parallel resonance and thus remove it from the effective circuit. Cathode follower stage serves extra duty as frequency doubler or tripler to provide output at up to 21 times crystal's fundamental frequency (7th overtone, tripled).

contains no resonant circuits. Instead, as **Fig. 10** shows, it makes use of two feedback networks rather than just one. One of these feedback networks provides the positive feedback necessary to sustain oscillator action. The other network is frequency sensitive, and is connected so as to produce negative feedback.

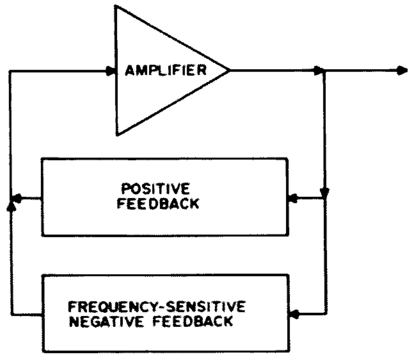


Fig. 10. Inductors aren't always necessary. Paired feedback networks as shown here may be used instead. If the negative feedback network is frequency sensitive so that feedback is reduced at one specific frequency, then circuit can oscillate only at that frequency. At any other frequency, negative feedback will cancel out the positive feedback and circuit can only amplify.

Because of the frequency sensitivity of the second network, the amount of negative feedback present depends upon the frequency of the signal. At almost all frequencies *except* the one at which oscillation is desired, there's enough negative feedback to cancel out the positive feedback from the first network, and the circuit is just a complicated amplifier.

At the desired operating frequency, though, the negative feedback is less. Some of the positive feedback remains; when the circuit is properly adjusted, the positive feedback left after the partial cancellation is still enough to sustain oscillation. The result is that the circuit is capable of oscillating at one and only one frequency; and any harmonics which might be produced in the process are reduced by the negative feedback.

Oscillators based on this principle are capable of providing sine waves in the audio range with less than 0.1% total distortion. Since no inductors are present, the frequency range over which such a circuit can be tuned is much greater (typically 10-to-1, compared with a 3-to-1 figure for the normal

L-C tuned circuit oscillator). Circuits which are based on this principle include the Wein bridge oscillator, the Twin-T oscillator, and the Bridged-T oscillator. Unfortunately, while the principle remains valid at radio frequencies, the feedback is much more difficult to control properly at high frequencies and so these oscillators have a typical upper-frequency limit of about 200 khz.

Not all oscillators produce sine waves, and most oscillators which produce non-sine waveforms are based on principles other than the resonant circuit. One of the most basic types of non-sine-wave oscillators is the multivibrator.

Whole volumes have been writen on the subject of multivibrators, and most discussions of them are sprinkled with detailed design equations which make the subject appear to be difficult to understand. Underneath it all, though, the multivibrator follows the basic principle of any oscillator as diagrammed in **Fig. 1**. It contains both amplifier and feedback sections. The problems emerge because of the difficulty in separating the two sections when a multivibrator schematic is examined.

The first problem appears when an attempt is made to isolate the "amplifier" part of the circuit. All multivibrators include not just one, but two amplifier stages. These stages may or may not be mirror images of each other, but they are connected so that each gets its input from the output of the other. So far as any signal within the circuit is concerned, the path of its flow is a closed ring.

We can give a ring a half-twist and turn it into a figure-8 pattern, and the various types of multivibrator circuits begin to show their similarities and differences if we draw their block diagrams in such a manner. **Fig. 11** shows such block diagrams for the three major classes of multivibrators.

In each of these, the "amplifier" stages shown as triangles are considered to be dc amplifiers, with 180° phase inversion from input to output. The three classes are distinguished by the manner in which the ring is closed. We can close the ring through coupling capacitors at both output-to-input connection points, as shown in **Fig. 11A**; we

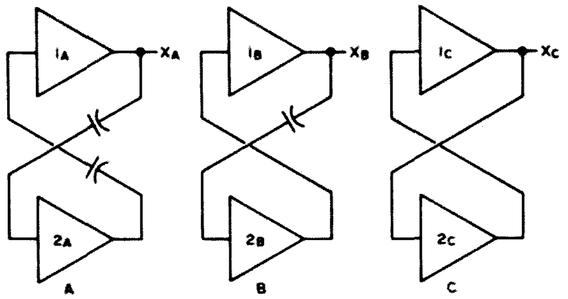


Fig. 11. Possibly the most widely used circuit in electronics today (although not so generally encountered in radio) is the multivibrator. Three types exist: astable (A), monostable (B), and bistable (C). Only major differences between types are in the manner of coupling stages. Astable has ac coupling only, monostable has one ac and one dc coupling, and bistable has only dc coupling. Only the astable is a true oscillator, but the bistable is the backbone of the computer industry and the monostable finds wide use as a timer. See text for details.

can use one dc connection and one capacitor as shown at B; or we can make both connections solid so that the dc path through the circuit is complete. These different connections give us three different types of circuit action.

In Fig. 11A, for instance, let's begin our examination with the assumption that the voltage at the input to amplifier 1A is at its lowest level. Since the amplifier has 180° inversion, the output will be at its highest level. If a change has occurred in this level recently, only the change will pass through the coupling capacitor. On emerging from the capacitor as the input signal to amplifier 2A, this rise in signal level causes the output of amplifier 2A to fall.

The fall is similarly coupled through the capacitor to the input of amplifier 1A to drive the level still lower. Eventually the limitations imposed by available power supply voltage will cause the output of 1A to stop climbing regardless of action at the input. No more changes can occur and everything levels off. However the capacitor coupling 1A's output to 2A's input is connected to high voltage on one side and to ground on the other, and so is charged. When circuit action levels off, the capacitor begins to discharge.

After a time delay determined by the size of the capacitor (which establishes how long it takes to discharge), the voltage at the input of amplifier 2A (which had been rising until things levelled out) begins to fall as capacitor discharge continues.

This fall in voltage at 2A's input appears as a rise at the output, and the rise in the output is coupled through the other capacitor to 1A's input. There it becomes an input signal for 1A, and causes the output level at point Xa to begin falling.

When the level at Xa begins to fall, the drop is coupled through the capacitor back to 2A's input. This accelerates the fall of the voltage level at 2A's input and drives the entire circuit to a levelling-off point exactly opposite to its previous condition, with 2A's output high and 1A's output low.

As soon as voltage change in the circuit reaches its limit in this direction, things reverse once again and the level at the input of 1A begins to fall. This brings us back to the point at which we started examining the circuit. We have gone through one complete cycle of multivibrator action. It will continue so long as power is supplied to the circuit.

Since both of the couplings in the ring are capacitive or ac couplings, the cirucit can never reach a "stable" condition but must continue vibrating from one state to the other. This circuit is called an "astable" multivibrator. Other names include "free-running" and, unfortunately, merely "multivibrator" or "multi." This is the only class of multi circuit which is capable of oscillating on its own—but the other two classes of multi circuits are of equal if not greater importance.

If we replace one of the capacitive ac connections with a solid dc connection as shown in Fig. 11B, for instance, we get a circuit which does have a stable state and so will not oscillate on its own.

For instance, as drawn here, the stable state provides a low-voltage level at point Xb. The input to amplifier 2B is low, which makes its output high, and this high-level output from 2B is connected directly to the input of 1B. In turn, the output of 1B is low. With voltage low on both sides of the capacitor, it is not charged. The circuit sits idle, doing nothing.

But if we momentarily insert a high-level input signal into amplifier 2B, this will drive 2B's output down to a lower level and since

1B's input follows right with it the signal level at Xb will begin to rise. The rise is coupled through the capacitor to 2B's input, causing 2B's output to fall even more. The momentary trigger input can be removed as soon as the internal signal gets all the way around the loop, because the feedback will take its place and drive the output of 2B as low as it can get. While this is happening, the output of 1B at point Xb rises.

Once 2B's output gets as low as possible it cannot change any more, and levels off. At this instant, Xb is at its highest level. Since the trigger signal is no longer present, there's a voltage difference across the capacitor, and discharge begins. As the capacitor discharges, the voltage at 2B's input falls. This causes 2B's output level to rise, which in turn drives Xb back down to a lower voltage.

Just as in the astable circuit, the action around the ring is cumulative and the voltage at Xb is rapidly driven as low as it can get. When it gets there, the output of amplifier 2B is at its highest possible level.

But unlike the astable circuit, when 2B's output goes to its high point the input to 1B is also high and *stays high*. There's no ac coupling there to force it to fall back down. And when Xb gets back to its low point to cause this, there's no voltage across the coupling capacitor, so everything is stable once again.

The result is that the momentary trigger input produces a single pulse at Xb. Since the duration of this pulse is determined almost entirely by the time it takes to discharge the coupling capacitor, the pulse's characteristics will be the same no matter how short the trigger input was.

This circuit, then, produces a single standardized output pulse for every input pulse it receives. The duration of the output pulse can be adjusted by choice of capacitor size and time constant. Such circuits are widely used to provide fixed time delays in the microsecond to multisecond range.

Because the circuit has one unstable state and one stable condition, it is known as a "monostable multivibrator;" other names include "one-shot" or "single shot."

If we replace both ac couplings with dc connections, as in **Fig. 11C**, we get a similar circuit but *both* states are stable. The signal

at Xc may be high, or it may be low. Whatever its condition, the level at 2C's output will be the opposite level, and things will remain unchanged until something is done from outside the circuit to change them. Then they will remain stable in the new state, until something else is done to change them back.

For example, let's assume that Xc is at its high level. This holds 2C's output low because of the direct coupling, and 2C's output being low keeps Xc high.

If we can momentarily ground point Xc, or drive it down with a brief negative-going pulse, this will make 2C's input low and the output of 2C will go up. When 2C's output goes up, point Xc comes to its low level and stays there.

Nothing else happens in the circuit, until we hit Xc with a positive-going pulse from outside. This increase in level at 2C's input drives the output of 2C down, and starts Xc moving up. The rise at Xc, coupled back through 2C's input, drives 2C's output still lower, and the cumulative action switches the circuit back to its original stage.

This "bistable" multivibrator circuit appears to be far removed from an oscillator, but as **Fig. 11** shows, the only difference is a couple of capacitors. The circuit provides a "memory" since its two states may be used to "remember" some previous condition. Under its more popular name of "flip-flop" it's the backbone of the computer industry.

Now that we've gone through the basic multivibrator action and watched it perform in all of the three classes of multi circuits, we ought to take a little closer look at the points which establish the timing of the astable and monostable varieties.

As we have seen, the timing depends critically upon the charge and discharge of the coupling capacitors in the circuit. They are, in fact, frequently called "timing capacitors."

The fundamental operating range of a multi is determined entirely by the timing in the coupling circuits—but this timing is itself influenced by many factors.

The capacitance itself is the primary factor, but the time constant is just as much affected by the circuit resistance as by the capacitance. Most usually, capacitance is used to select a major timing range, and the resistance is then adjusted to provide a fine-tuning of the time constant.

Timing is also affected by the operating voltages supplied to the circuit. The higher the voltage, the smaller the portion of the discharge curve which will be used.

While the multivibrator's fundamental timing is established by the time constants of its coupling networks, the actual operating frequency for a multi can be changed over a relatively wide range without adjusting time constants. This is done by synchronizing the multi to some other signal.

Because the action in all multis depends upon a trigger signal (in the astable circuit, the trigger signal is provided internally by capacitor discharge; the monostable requires one external trigger but provides its own second trigger internally; the bistable requires that both triggers be external), a switch from one state to the other can be made to occur "early" by injecting an external trigger near the end of the multi's "normal" cycle. This external trigger touches off the switchover without waiting for capacitor discharge to provide an internal trigger.

If the trigger-signal level is properly chosen, it will affect the circuit only near the end of the normal cycle. This means that the trigger signal may be applied at a frequency as much as 10 times that of the multi, and the first 9 triggers during each multi cycle will be ineffective while the 10th one triggers off a new switchover. The multi then becomes a frequency divider; this is one of its most frequent applications in ham radio.

For instance, triggers may be developed from the output of a 100-khz crystal oscillator and applied to a 10 khz multi. The multivibrator will then be locked in frequency to the crystal. More triggers can be developed from the 10 khz multi output, and applied to another 1 khz multi. The process can be continued as long as we like. All the intermediate signals we get will be of the same frequency accuracy and stability as our original 100 khz signal.

Normally, only one division occurs, because marker signals at 10 khz intervals are usually adequate for amateur measurement

needs—but this is a matter of choice, not a situation dictated by limitations of the basic idea.

The monostable may be synchronized in the same fashion, because most practical monostable circuits ignore any triggers which arrive during the unstable period (the circuit of **Fig. 11** will not necessarily do so, being simplified to the absolute essentials). The monostable, in fact, is more reliable as a frequency divider than is the astable, because an astable multi will keep running if the sync signal disappears. The monostable, on the other hand, produces output signals only so long as the input signal is present. This lets you know that any signal you have is accurate; with an astable divider, failure of the 100 khz signal would give you no indication of failure—but the multi's output signal might be almost any frequency, rather than 10 khz.

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Topographical Maps for the Radio Amateur

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For those of you who are not familiar with this fine addition to the resources of the radio amateur, allow me to formally introduce you. "A topographic map is a graphic representation of selected manmade and natural features of a part of the earth's surface plotted to a definite scale. The distinguishing characteristic of a topographic map is the portrayal of the shape and elevation of the terrain."[1]

"Topographic maps record in convenient, readable form the physical characteristics of the terrain as determined by precise engineering surveys and measurements. They show the location and shape of the mountains, valleys, and plains; the network of streams and rivers, and the principal works of man."[2]

These maps have many uses such as planning airports, highways, pipelines, transmission lines, and other construction. They are an old friend to the outdoorsman who may have discovered their advantages in such activities as hunting, fishing, or camping.

Why then, do I feel they are of importance to the amateur radio operator? Let me mention a few of the uses that I have experienced in the last several years. These maps do an excellent job of showing elevation and terrain. This would obviously suggest a simple method of finding a high spot for field day, a relay point for vhf and uhf equipment, a nice place to build a home and an antenna farm, and a good place to take the family for a ride and a picnic and possibly do a little hamming. They are very helpful in transmitter hunts,

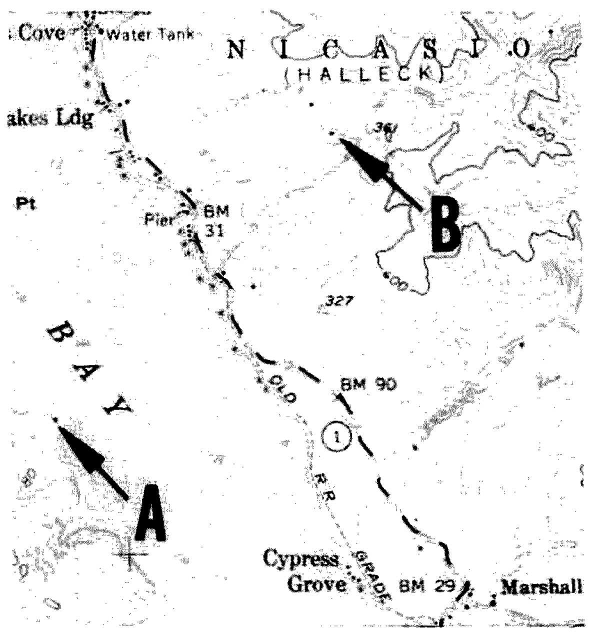

Fig. 1. Contour lines at 80′ intervals.

both for the hunter and the hunted. In emergencies, topographic maps can help your organization place its equipment quickly and in the most efficient location. These maps may help you to obtain a realistic idea of the capabilities of your uhf or vhf station or possible performance of your hf station on groundwave. I will discuss these applications more thoroughly later in the article.

As with any tool, it is no more effective than your ability to use it. I will attempt to provide you with a short course in the reading of topographic maps. In addition, you may want to send for the free booklet, "Topographic Maps," from the Map Information Office, U. S. Geological Survey, Washington, DC 20242.

I will relate to you those map skills

which will apply to an amateur's use of these maps.

Symbols are the graphic language of maps. Symbols for water features are generally printed in blue; man-made objects are shown in black and green is used to indicate wooded areas as opposed to clearings. Red is used to emphasize important roads, show built up urban areas, and public land subdivision lines. Symbols which show the shape and elevation of land surfaces are printed in brown. Some symbols of special concern to the amateur radio operator may be power transmission lines, boundries, swamps and roads.

The symbols which are of primary importance to the radio amateur are the brown contour lines which indicate elevation and are in turn an interpretation of the terrain. To understand the contour symbol, think of it as an imaginary line on the ground which takes any shape necessary to maintain a constant elevation above sea level. See **Fig. 1**. Remember, these maps are made from aerial photos, and you are always looking from directly above the terrain, but in real life you have a vertical or worm's eye view of the terrain. It may take you a while to get used to looking at these maps from a new perspective. The shoreline shown on the map illustration is a contour line representing zero elevation or sea level. If the sea were to rise and cover the land, the shoreline would trace out each of the contour lines shown on the map. It is just like when you sit in the bathtub, the water rises at an even rate. When you get out, the rings you leave behind are like the contour lines on the map. Try this next time when you are playing with your rubber duck and your battleship. Since the vertical difference in height between contour lines is 80 feet, the shoreline would coincide with a new contour line for each 80 feet that the sea rose.

For easier reading, index contour lines are added usually every fourth or fifth contour line. They are accented by making the lines heavier. This will depend upon the contour interval. The contour interval is the number of feet that the elevation changes between concentric contour lines. In **Fig. 1**, it is 80 feet. This information can be found in the map margin. This will also tell you about the general elevation of an area represented by the map you are studying. For instance, if the contour interval is 5 or 10 feet, there is usually little elevation change, and it is a relatively flat area; if the contour interval is 50 to 100 feet, the map will represent an area of great elevation changes, mountains, ridges, valleys, etc. Figures in brown along contour lines give the elevations of the lines above sea level. The elevation at any point on the map can be read directly or interpolated. Therefore, point A in **Fig. 1** is 80 feet above sea level.

Another simple method of further interpreting elevation changes on topographic maps is illustrated in **Fig.** 2. Circle A indicates an area where the contour lines are very close together; this shows that the elevation changes quickly as it would on a steep ridge, valley or canyon. Circle B indicates an area where the contour lines have greater spacing; this shows that the elevation changes slowly as it would for a gently sloping hill. This information in conjunction with contour interval should make it possible for you to interpret terrain, primarily elevation change.

Also of aid in understanding and using these maps are the margins. The map margin is the space outside the projection

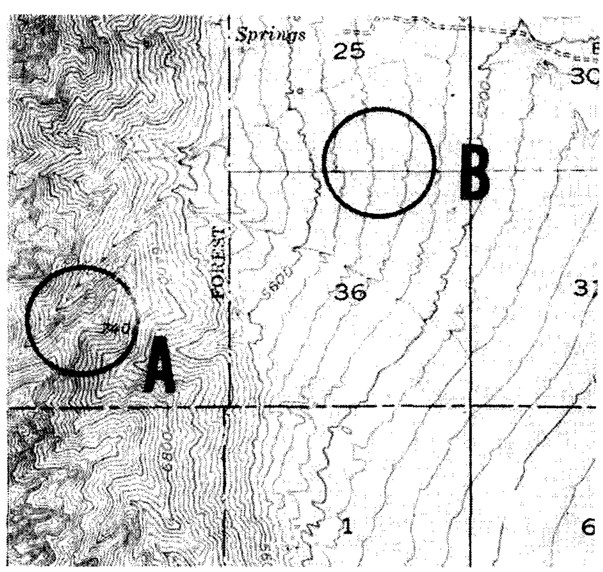

Fig. 2. Contour lines closer together indicate steeply sloping ground.

lines of the maps. This space contains such useful information as the scale, contour interval, area covered by the map, and the date that it was last revised.

Now let us consider specific amateur radio uses for our new found companion. When considering field day or that family picnic, access to many areas can be determined quickly and accurately. Topographic maps far exceed road maps in detail and accuracy. Since they are at a larger scale, they often indicate roads or trails considered unimportant by makers of road maps. Rural areas are divided into townships which makes it easier to locate the owner of a prime transmitting and receiving area. Generally if you have information concerning townships and range lines, you can locate an owner by checking with the register of deeds, surveyor, or assessor of the township or county seat. Later you may even decide that you would like to purchase a particular piece of real estate because of its radio potential; DXCC, here we come!

For those people engaged in transmitter hunts, the afore mentioned ideas will also apply. If you are the hunted and are trying to place the hidden transmitter intelligently and slyly, consider placing it at the base of a steep ridge; at vhf frequencies you will obtain some weird effects. You might also consider a placement which would cause several reflections of the signal. This will really drive them nuts. The map will give you a panoramic view of area considered "fair game" for hiding the transmitter and will probably stir many ideas as you consider the overall picture presented to you.

Have you or your organization ever considered placing a vhf or uhf relay station? It is an efficient and reliable method of conducting communications over a short route. By checking the topographic maps, you may find that there are already some commercial installations in your area. Often they can be prevailed upon to allow you use of towers, buildings, and electrical connections as a public service. If not, you may be able to find an accessible location for the relay equipment. There may even be a fellow ham who already owns or lives at a location which is suitable.

How could you go about assessing your present location as a vhf or uhf site? Obviously, elevation is very important. How your location's elevation compared with your surroundings will greatly determine your ability to communicate. Here is one method which you could use to determine whether you could consistently communicate with another site several miles away. **Fig. 3** will illustrate what I mean. Suppose your location is point X and your friend's location is point Y. Draw a straight line between them. Follow this line carefully and check the elevation of the contour lines in between the two points. This will tell you what problems your signal will run into as it travels from point X to point Y. Depending upon distance between points, you may have to consider the curvature of earth, the type and height of antennas; you should be able to make some reliable prediction about your ability to communicate. This same procedure may be used for several different points at varied distances. You will soon have a pattern of communications. Now you should be able to pick out which stations you can work directly and which stations you may have to reach by relay. This method could also be very helpful to a group running a net. It should be possible to pinpoint that site which would be best suited as net control. This could save a great deal of time and cause a lot less net members to become discouraged because they have trouble communicating with the net control and receiving important net

bulletins. Many of these same techniques can also be applied to hf groundwave capabilities.

All of the ideas I have already mentioned can be used to attack the most important problem; quick and efficient emergency communications. You should have previously prepared a map of the area you or your organization may have to serve in an emergency. Important point-to-point communication lanes should be marked and tested by on-the-air trials. Alternate routes should be available. Other important things which could be keyed to this map would be the locations for emergency power, hospitals and first aid stations, alternate routes for transportation, etc. These maps are inexpensive enough so that each member of an organization could have one in his car and/or home. They could make the difference between lives lost or lives saved.

Now that I have convinced you that you really need some topographic maps to be an effective amateur radio operator, I will give you the necessary information to obtain them. Indexes showing published topographic maps in each state, Puerto Rico, and the Virgin Islands are available free on request to the U. S. Geological Survey, Washington DC 20242, or Federal Center, Denver CO 80225. The index of your state will show you how to obtain maps of your specific location. These indexes also contain lists of special maps, addresses of local map dealers and federal map distribution centers. An order blank and detailed instructions for ordering maps are supplied with each index. To give you some idea of how inexpensive these maps are, one of your location which averages 18 inches by 36 inches in size, costs thirty cents when ordered individually. That also includes postage. There are discounts when larger numbers of maps are ordered. I think you will have to admit, it's a very good deal.

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Notes

1. *Topographic Maps*, Geological Survey.
2. *op. cit.*

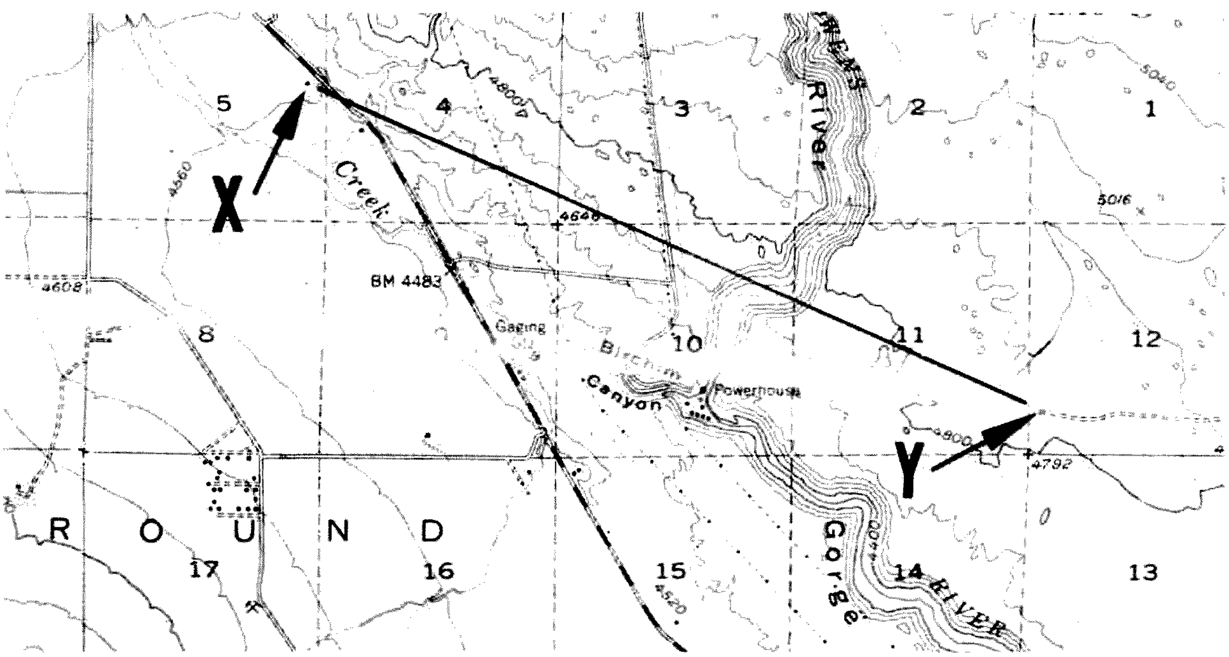

Fig. 3. The line from point X to point Y traces the signal path. Note possible sources of interference.

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Fascinating Fundamentals II: Magnetism, The Mysterious Lodestone

It was a balmy spring day in the year 435 B.C. A sturdy ship made its way slowly across the water. The captain stopped pacing the deck and looked sleepily out at the towering mountains on the nearby island. Suddenly there was an ominous creak. Something flicked by the captain's ear, drawing a little blood as it went. Puzzled, he looked around. He opened his mouth in astonishment at the sight of three shields sailing through the air toward the distant island. A warning shout from behind, and the captain hit the deck as a sword whipped past his head. Looking up cautiously, he gasped as he beheld planks which had fallen from his ship bobbing in the wake. The awful truth dawned on him. He had sailed into the grip of the terrible Lodestone Mountain.

That looks like the start of a king-sized fish story, but the fact is, sailors of old actually believed such a mountain existed. It was one of the calculated risks of going to sea. So great were the magnetic powers of the fabled mountain that the nails would be drawn from passing ships, and they would disintegrate! This was typical of the legends concerning lodestone and magnetism in the days of yore.

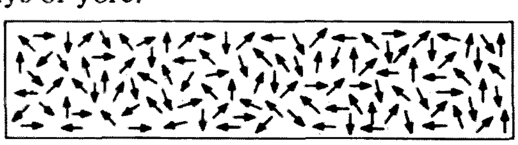

Fig. 1. When a piece of metal is NOT magnetized, the molecules all point in different directions.

Just when magnets were discovered, and by whom, is lost in antiquity. While the Chinese are known to have used magnetic compasses around 300 A.D., wild and wonderful tales of this mysterious force circulated around both the eastern and western worlds centuries earlier.

For instance, there was Magnes, a shepherd boy whose nailed boots and iron tipped spear were clamped to the ground. His name is thought to be the origin of the word Magnet

Or was it derived from Magnesia, a place where great quantities of this magical stone were found? Who knows?

For a long time, though, lodestone, a naturally magnetized mineral, was shrouded in mystery. In the west, the compass came into widespread use around the turn of the 13th century, but superstition still took priority over knowledge. It was believed that garlic would interfere with the compass. (I wonder how Marco Polo survived!) Also, while scientists agreed that the earth was flat, they knew that it had magnetic properties, and magnetic poles.

In 1269, Peter Peregrinus used a magnetized needle to discover the concentrated areas of power in a chunk of

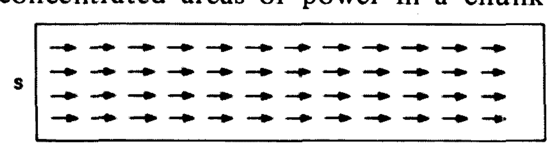

Fig. 2. Magnetizing causes the molecules to line up so that all their magnetic fields combine.

lodestone. William Gilbert, in 1600, confirmed Peregrinus' findings, and pressed the theory that the earth itself was a large magnet.

Today there is still a lot that is unknown about magnetism, but scientists nonetheless have a pretty good idea as to how it works. There are only three elements which are strongly affected by magnetism; namely, iron, nickle, and cobalt. All other elements are either very weakly affected or not at all. The alloy, alnico, most widely used of all magnetic substances, is a mixture of aluminum, nickle, and cobalt.

In a magnetic substance the molecules can be pictured as if they were themselves tiny magnets. Normally, they are all pointing in different directions. But when the substance is magnetized, the molecules line up together so that their magnetic fields reinforce one another. Anything that will cause a disarray of the molecules, such as jarring or heating will weaken or destroy the magnetic powers.

You can easily magnetize a tool or other magnetic object with a magnet.

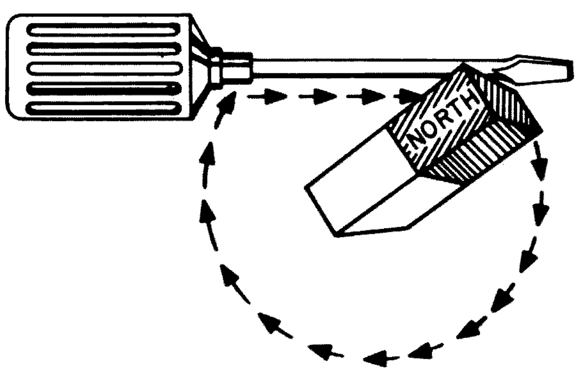

Fig. 3. Magnetic power can be transferred from the magnet to the screwdriver.

Simply rub the magnet from one end of the tool to the other. Take the magnet away, and go back to the point where you began and rub the tool again. Several strokes like this, and the tool should be magnetized.There are two ways you could de-magnetize it. First you could heat it, but that would destroy the temper. Better still, hold the tool within the loop of a soldering gun tip, pull the trigger, and slowly withdraw the tool. The alternating current through the tip produces an alternating magnetic field which destroys the fixed order in the tool. Try it; it works.

A magnetic field can be seen quite easily. Simply lay a sheet of paper over the magnet, and then sprinkle iron filings on the paper. The iron filings will line up in a very nice sketch of the magnetic field.

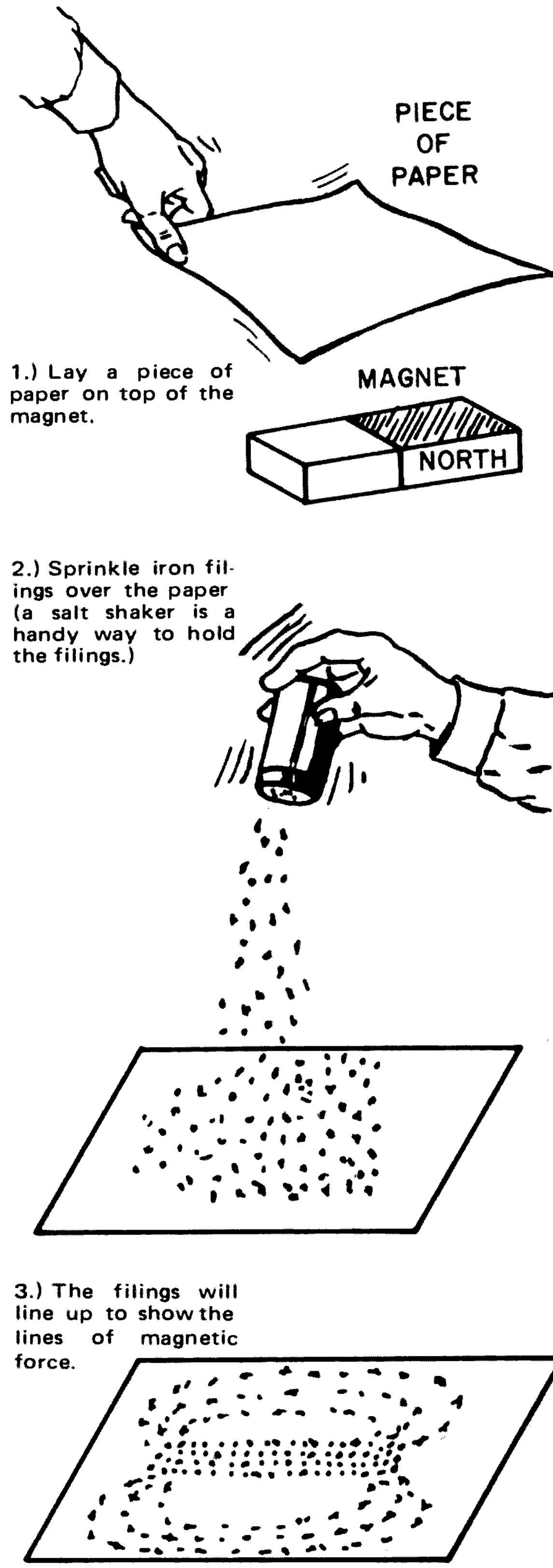

Fig. 4. Sketching a magnetic field.

The ends of the magnet, or the points where the power is concentrated, are called the POLES. They are so called because, if you hang up a bar magnet and allow it to swing free, the ends will line up pointing north and south. If you bring two north-seeking poles together, they will repel each other strongly. If you bring a north-seeking and a south-seeking pole together, they will attract.

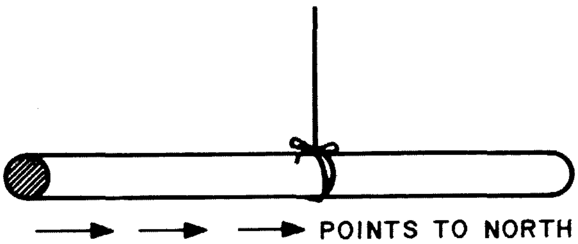

Fig. 5. A bar magnet, hung up so that it can swing freely, will point north.

The needle of a compass is really a small magnet. I remember once, as a Cub Scout, sticking a magnetized needle through a cork and letting it float. Sure enough, it turned around until it pointed north.

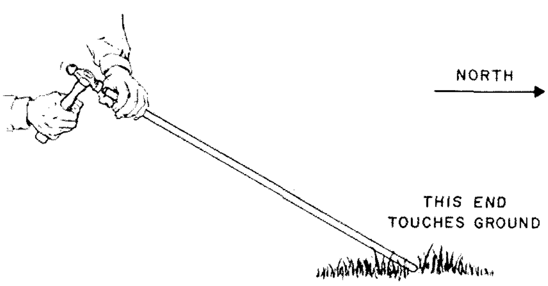

Fig. 6. To magnetize a steel bar, touch one end to the ground, point it north, and rap it a few times with a hammer.

Try this one. Take a long steel rod, point it north and touch one end to the ground. Strike the other end a few raps with a hammer. Now bring the rod close to a compass. When one end of the rod is brought near the compass, the "north" end of the needle will swing toward it. Turn the rod end-for-end, and the other end of the compass needle will point to it. That is iron-clad proof of magnetism. If you're lucky, it may even be strong enough to pick up a small pin. You will have magnetized the rod from the earth's magnetic field!

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FCC ANNOUNCEMENT

1. On August 24, 1967, the Commision adopted its Report and Order in Docket No. 15928 (FCC 67-978, 9 FCC 2d 814), which made the allocation of certain sub-bands as "incentives" exclusively to the Extra and Advanced Class amateur operator licenses. The first phase of these allocations went into effect November 22, 1968, and the second phase is scheduled to become effective November 22, 1969.

2. In its Report and Order, the Commission said: "Notwithstanding this schedule, the Commission intends careful review and if it is determined that there is insufficient occupancy of any part of the reserved frequency segments, then the effective date of the implementation schedule will necessarily be stayed in whole or in part, as appropriate." In its Order denying RM-1287, August 9, 1968, the Commission said regarding Docket No. 15928 that: "... it is its intention ... to make necessary changes if the effective utilization of the frequencies involved is threatened." In the same Order, it said: "So that Commission review may be meaningful, it is planned to gauge the results following each stage of implementation."

3. Three petitions and much correspondence have been received suggesting variations and counter proposals to the current rules and the scheduled frequency reservations. RM-1357, filed October 7, 1968, by Neil W. Petlock, proposed an advanced telegraph license which would require only a high speed code test to qualify for use of the Extra Class telegraphy allocations. RM-1393, filted January 1, 1969, by John A. Attaway, proposed that the exclusive Extra Class telegraphy segments 7000-7025 and 14000-14025 khz not be expanded on November 22, 1969, and suggests that a reservation of a 10 khz instead of 25 or 50 khz would provide a better balance of band usage. RM-1493, filed August 6, 1969, by Emery T. Mitton, proposed that the Extra-Advanced exclusive sub-band 50.0-50.1 mhz be reduced to 50.0-50.05 mhz and a telegraphy only segment of the band be established at 53.5-54.0 mhz so as to be available to Technician Class operators.

4. The Commission has considered the abovementioned petitions and correspondence, occupancy surveys of the reserved sub-bands, and license statistics which show a definite shift toward the higher classes of licenses in reaching the following conclusions:

a. The exclusive telegraphy sub-bands for the Amateur Extra Class licenses are relatively lightly used compared to the telegraphy usage of the balance of the band by the other Classes of operators. Therefore, further expansion is not justifiable as a productive incentive to qualify for the Extra Class license at this time.

b. The telephony sub-bands reserved for exclusive operation of Advanced and Extra Class licensees are so well used during periods of moderate and heavy amateur activity that the previously adopted further expansion is necessary for the purpose of providing a continuing incentive to qualify for these classes of licenses. Comparison of the current number of licensees of each class and the space available to them in each of the four amateur high frequency telephony bands under consideration confirms the need for such adjustment. Therefore, the telephony allocations in the 3.8, 7.2, 14.2, and 21.25 mhz bands will go into effect on November 22, 1969, exactly as previously adopted by the Commission on August 24, 1967.

c. The interest in, and use of, the current space reserved for Advanced and Extra Class operators between 50.0 and 50.1 mhz is so moderate that the further expansion to 50.00-50.25 mhz scheduled for November 22, 1969, is unwarranted.

5. In reaching the above conclusions, the Commission has given consideration to the proposals advanced by the petitioners. The proposal of Mr. Petlock (RM-1357) is not consistent with the Commission's intent to encourage a balanced achievement at the highest level, both in code and technical ability, and is therefore denied. As noted above, further expansion of any of the four Extra Class exclusive telegraphy sub-bands is not justified by the present level of activity. However, a reduction at this time from the present 25 khz segments as proposed by Dr. Attaway (RM-1393) would not be consistent with the desirability of continuing an incentive to qualify for the Extra Class license. Accordingly, his petition is granted to the extent provided herein and denied in other respects. In view of Mr. Mitton's statement (RM-1493) that the 50 mhz band is very lightly occupied, and in the absence of any affirmative showing for a need to realign the frequencies in that band, his petition is denied.

6. In view of the foregoing, the Commission finds that the amendments to Part 97, Amateur Radio Service, as set forth in the attached Appendix, are in the public interest, convenience, and necessity. The authority for such amendments is contained in Section 4(i) and 303 of the Communications Act of 1934, as amended.

7. Accordingly, IT IS ORDERED, That effective November 22, 1969, Part 97 of the Commission's Rules IS AMENDED as set forth in the attached Appendix.

8. IT IS FURTHER ORDERED, That the petitions filed by Neil L. Petlock (RM-1357), John A. Attaway (RM-1393), and Emery T. Mitton (RM-1493), to the extent that they are at variance with the rule changes adopted herein, ARE DENIED.

FEDERAL COMMUNICATIONS COMMISSION
Ben F. Waple
Secretary

Appendix

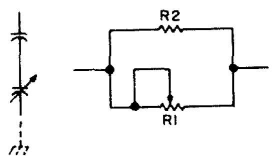
Part 97 of the Commission's Rules is amended as follows:

Section 97.7(a) & table, and par (c) [Note deleted] are amended to read as follows:

§97.7 Privileges of operator licenses.

Lowering Values

A quick method for lowering the maximum value of variable resistors and capacitors is shown in the illustration. The simple parallel combination of resistor and pot will restrict the upper resistance value of the pot. With a 1 meg pot and a 1 meg shunt resistor, the maximum total resistance of the combination will be held to 500K. The only disadvantage of this circuit is that the linearity of the pot (if it was linear to begin with) will be destroyed, but this isn't too serious in amateur work. The shunt resistor should not be less than one-tenth the value of the pot for smooth operation. All of the above applies to capacitors except that a series combination is used. By using the parallel resistance or series capacitance formulas in a slightly modified form you can determine the value of the shunt resistor or series capacitor. For instance, when the total resistance and the value of the pot are known, the value of the shunt resistor



can be found by using the formula R2=RtR1 /R1-Rt where Rt is the total resistance. The same formula can be .used for capacitors in series. As an example, a 365/pf broadcast replacement variable can, in effect, be turned into a 100/pF variable by soldering a 140 pF fixed capacitor in series with it.

. . . Charles Jimenez WA4ZQO

(a) *Amateur Extra Class and Advanced Class.* All authorized amateur privileges including exclusive frequency operating authority in accordance with the following table.

Frequencies	Class of license authorized
3500 - 3525 kc/s 3800 - 3825 kc/s 7000 - 7025 kc/s 14000 - 14025 kc/s 21000 - 21025 kc/s 21250 - 21275 kc/s	Amateur Extra Only
3825 - 3900 kc/s 7200 - 7250 kc/s 14200 - 14275 kc/s 21275 - 21350 kc/s 50 - 50.1 Mc/s	Amateur Extra and Advanced

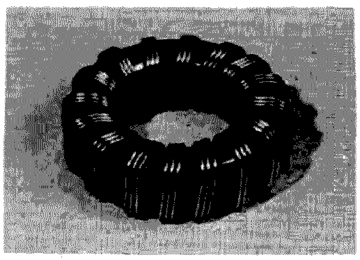
(c) *Technician Class.*
All authorized amateur privileges on the frequencies 50.1-54.0 Mc/s and 145-147 Mc/s and in the amateur frequency bands above 220 Mc/s.

1970 Amateur Radio Buyer's Guide

The information compiled herein is as accurate as can be expected, considering that it was compiled by the editor during the short lulls between meals, coffee breaks, staff uprisings, hamfests, and hunting trips. The prices listed may or may not be accurate, probably. Possibly not. Ditto product specifications. We hope you will find the listing helpful, somewhat.

Antennas & Accessories

● Amidon Associates, 12033 Otsego, North Hollywood CA 91607



Toroid balun kit, either 4:1 or 1:1 ratio, for matching balanced to unbalanced lines, coas to twinlead, etc. Used for dipoles, quads, inverted vees, etc. $5 with complete instructions. Amidon also handles a wide range of toroid forms, send for list.

● Antenna Specialists, 12435 Euclid, Cleveland OH 44106. Mobile and base station antennas for 2-6-10 meters. Accessories for mobile whips.

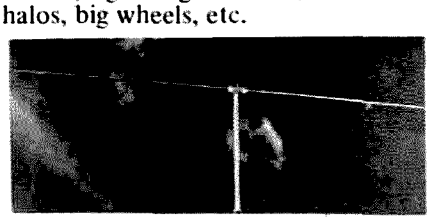
● Barker & Williamson, Canal Street, Bristol PA 19007. Coaxial antenna switches, coaxial dipole antenna connector, TVI low pass filters.

● Bilada Manufacturing, Box 263, Manasquan NJ 08736. Balun for dipoles.

● Cornell Dubilier, 50 Paris Street, Newark NJ 07101. Antenna rotators, Ham-M, AR33, etc.

● Cubex, Box 732, Altadena CA 91003. Cubical quads, 2-3-4 elements, 3 bands.

● Cushcraft, 621 Hayward, Manchester NH 03103. Yagi & collinear VHF beams, HF beams, mobile antennas, lightning arrestors, verticals, halos, big wheels, etc.



This is the Cushcraft Trik-Stik, a dipole that can be mounted horizontally or vertically and used for any VHF band, ¾ thru 10 meters, aircraft, weather, TV, FM, etc.

● Dow-Key, Box 265, Broomfield CO 80020. Coaxial switches and relays.

● Drake Manufacturing, Miamisburg OH 45342. High and low pass filters.

● Dusina Enterprises, 571 Orange Grove, Melbourne FL 32901.

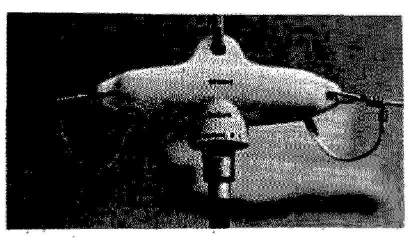
40 meter super gain antenna (see 73, October 1969). All you need are five 8' sticks and this antenna. $14.75 pp.

The Guerilla, 40/75M dual band 1 kw antenna. 50% power gain over dipole. Easy to erect. $33.75 pp.

● Gam Electronics, 191 Varney Street, Manchester NH 03102. Mobile and base VHF antennas.

Gotham, 1805 Purdy, Miami Beach FL 33139. HF beams, quads, verticals.

● O. Watson Greene, Wakefield RI 02880.



Coaxial center connector for dipoles, etc. Waterproofs and protects connection to the antenna from the feed line. With balun built in for matching balanced antenna to unbalanced feed $10. Without balun $6.

● Hi-Par, 347 Lunenburg, Fitchburg MA 01421. Mobile halos, VHF beams.

Saturn 6 mobile halo antenna, $17.

6MHT portable six meter three element beam, $14.

HT2M portable two meter 8 element beam, $17.

S4 bumper hitch, $3.

● Hirsch Sales, 219 California Drive, Williamsville NY 14221. Lightening arrestor. Zap-Trap, right angle connector-arrestor, $2.90.

● Hy-Gain, NE Highway 6, Lincoln NB68501. Beams, quads, verticals, dipoles, mobile whips, accessories.

● E. F. Johnson Co., Waseca MN 56093.

SWR coupler, 250-37, $11.75.
SWR indicator, 250-38, $25.
TR switch 250-39, $30.
275 watt matchbox 250-23-1, $65.
Matchbox with SWR indicato 250-30-3, $154.50.

● JSX Products, Box 47, Newberg OR 97132.

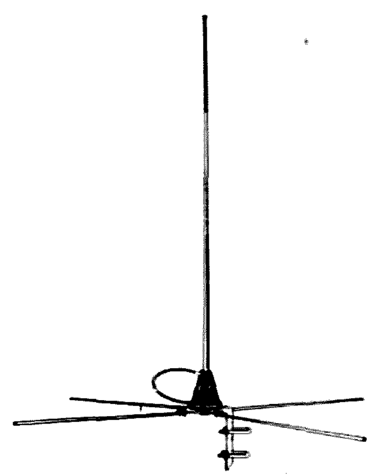
Hamster 2B compact antenna for 40-80 meters, $71.70 pp, complete in traveling case.

● Kirk Electronics, 6151 Dayto Liberty Road, Dayton OH 45418

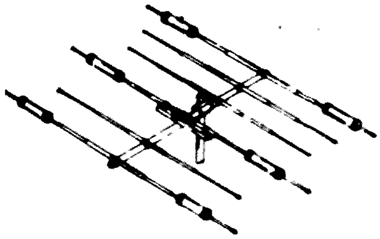
Fibreglass quads and components for quads.

● Lattin Radio Laboratories, Bo 44, Owensboro KY 42301. Al band doublet $35.00.

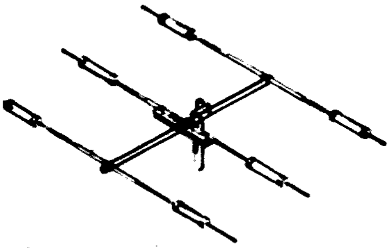
● Mosley Electronics, 4610 N Linbergh Bvd, Bridgeton MC 63042. Dipoles, beams, grounc planes, accessories, verticals, etc.



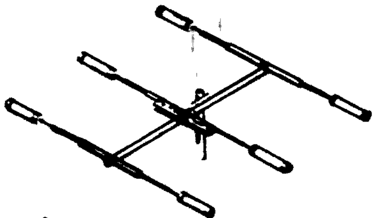
Model DI-2, 5/8 wave omni directional vertically polarized 2M ground plane. $10.58. 1 kw.



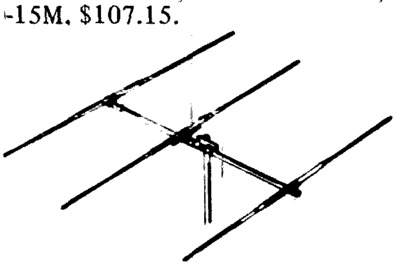
Classic 36, six element,)-15-20M, 1 kw, $171.92.



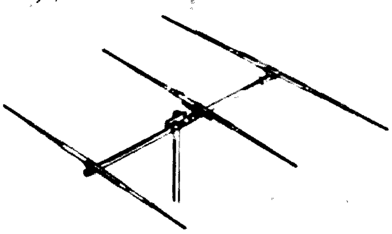
Classic 33, three element,)-15-20M, $145.15.



Classic 10-15, three element, -15M, $107.15.

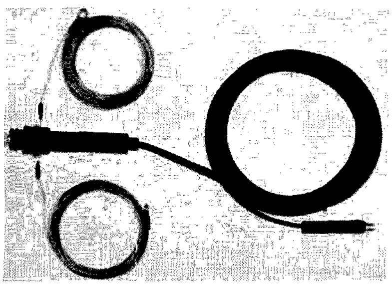


Classic 10, three element single nd, $57.64.



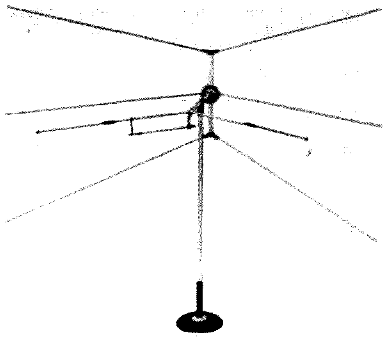
Classic 15, three element single nd, $66.50.

• Murch Electronics, Box 35, anklin ME 04634. Dipole antenas.



Fully adjustable dipoles and accessories. Models available for open wire line or coax line, 40 or 80 meters. Model 51-51-5, kw, 10-80 meters $34.50.

• New-Tronics Corp., 3455 Vega Avenue, Cleveland OH 44113. Antennas, mobile antennas, accessories.



Coveya 6 antenna, 10 db gain, kw, six meters, $39.90. Hustler mobile antennas for 10 thru 75 meters, folding fase sections, bases, springs, gutter clips, and a profusion of accessories.

Hustler II mobile antenna, shorter than 40", short enough for garaging, supplied complete from radiator to PL259 connector, installs in minutes without drilling, wire trimming, or soldering, for 10-05-20 meters.

• Omega T Systems, 300 Terrace Village, Richardson TX 75080.

Antenna noise bridge tests antenna system for resonant frequency and impedance. tests any type antenna, 1-100 mhz, $25 pp. The TE7-02 is an extended range model, covering 1-300 mhz, $35.

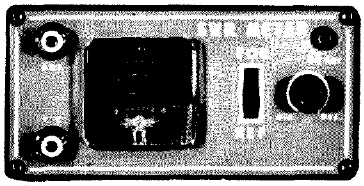
• Productos Joga, Calle 50 x 45 Num. 431, Merida, Yuc., Mexico.

Two element three band quad, handles a kw, single feed line, unique shape allows 4'6" boom length. Withstands 100 mph winds.

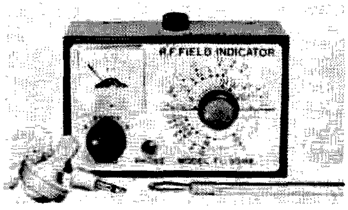
• Quement, 1000 S Bascom, San Jose CA 95128.

In line SWR bridge, kw, reads forward and reflected power simultaneously, $17 pp. SWR bridge and field strength meter, kw, good through two meters, $10.

• Redline Company, Box 431, Jaffrey NH 03452.

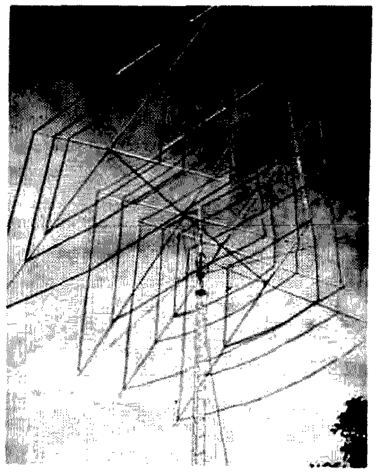


SWR meter, 1 kw, 52 ohms, model SE405, $16 pp.



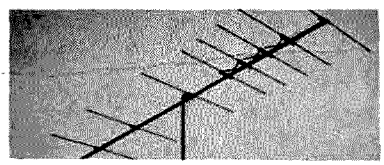
RF field strength meter 1-400 mhz, with five section antenna and earphone for checking modulation, listening to carrier, magnetic base for mobile, model FL30, $9.50 pp.

• Skylane Products, 406 Bon Air Drive, Temple Terrace FL 33617. Quads.



Two, three, four, five and six element quads, one and three band quads, bamboo or fibreglass elements. Four element fibreglass 10-15-20M quad only $199.95.

• Swan's Antenna Co., Box 1122, Stockton CA 95201. Two and six meter beams.



Band pass is increased by using four driven elements. Two meter 11 element beam covers 143-149 mhz with 15 db gain, 12-1/2 foot boom, 6 lbs, $24.95.

• Swan Electronics Corp., 417 Via Del Monte, Oceanside CA. Mobile antennas.

Model 55 Swantenna, five band

remote band switching mobile antenna. About 8' high, 500 watts, 5-1/2 lbs, $95.

● Telrex Laboratories, Asbury Park NJ 07712. Antennas, I.V. kits, towers, accessories, etc.

Broad band baluns, inverted Vee antennas, antenna rotators, beams for all amateur bands from 3/4 meter through 40 meters (three element wide spaced beam, 177 lbs, under $900), two band, three band and even four band beams.

● Unadilla Radiation Products, Unadilla NY 13849. Quads, baluns.

W2AU navy type broad band balun, stainless steel hardware, full kw, 1:1 or 4:1 types, see page 49 for details.

● Waters Manufacturing, Wayland, MA 01778.

Coax switches, SP6T $14.50, SP5T $14, SPDT $13. Also mobile antennas and accessories.

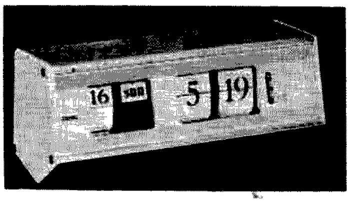
● Western Electronics, Dept. A, Kearney NB 68847. Antennas.

Clocks

● The Farmerie Corporation, 114 Spencer Lane, Glenshaw PA 15116.

● Pennwood Numechron Co., 7249 Frankstown Ave., Pittsburgh PA.

● Redline, Box 431, Jaffrey NH 03452.

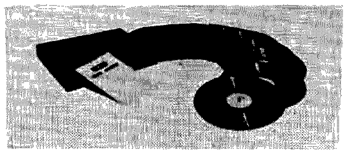


Calendar clock, available in 24 hour or 12 hour movements, self starting, indicates day or month and day of week, brushed aluminum, $40 pp.

Digital clock, available in 24 or 12 hour movements, cases in charcoal gray, coral red, light blue, white, brown, or clear plastic which shows mechanism clearly, $25 pp.

Code Records & Tapes

● Ameco, Box 6527, Raleigh NC 27608.



Code records for all license grades, code practice oscillators, books on learning code. 8-18 wpm record, $3.95, number 103-33. 104-33, supplement, $3.95. 104-33 from 13 to 22 wpm, $3.95. 106-33, 19 to 24 wpm, $3.95.

CW, a 50¢ book on how to learn the code using a new and improved learning system that has all the others beat a mile. Lays the foundation for developing truly high speed code ability.

● Epsilon Records, 206 E Front St., Florence CO 81226.

Revolutionary new word method code learning course. Three 12" records with 2-1/3 hours of instruction for only $9.95. Based upon modern psychological techniques. Available also on magnetic tape at $9.95 or on cassette for $10.95. This is a very easy way to get that 13 per.

● Heath Company, Benton Harbor MI 49022.

HDP-32 set of three code records, $9.50.

● Instructograph Company, 4700-Q Crenshaw Blvd., Los Angeles CA 90043.

● Pickering Radio Co., Box 29, Portsmouth RI 02871.

CM-1 5-7-9 wpm tape code groups and punctuation. CM-1-1/2 code at 11-14-17 wpm. CM-2 (for Extra Class) 20-25-30 wpm. Each tape about 90 minutes. $5.95 for one, $11 for two, $15 for all three, pp. Available on 7" reels at 3-3/4 ips or 3-1/4" reels at 1-7/8 ips, both two track.

● Rand Laboratories, Box 102, Winthrop ME 04364.

15 wpm tape, $5.49 for 3-3/4 ips 5" reel, complete with QRM, very realistic. Extra Class tapes (two hours) with 40 minutes each at 15-20-25 wpm, 20 minutes each speed sprinkled with QRM to prepare you for gly reality, $5.49 pp.

● Hayden Book Company, Inc., New York NY.

Sight-N-Sound courses. Novice, $9.50, 0-8 wpm, 3 records. Advanced, $9.00, 9-20 wpm, 3 records. Complete course 0-20 wpm, six records, $16.

● Teleplex Company, 739 Kazmir Court, Modesto CA 95351.

Teleplex system with tone generator, $58. Without tone oscillator, $49.50. Code is recorded on drum, speed is infinitely variable.

Crystals and Calibrators

● American Crystal Co., 2366, Kansas City MO 64142.

● Crystek, 1000 Crystal Dr., Fort Myers FL 33901.

● Denver Crystals, Rte. 1, Box 357, Parker CO 80134.

● HAL Devices, Box 365L, Urbana IL 61801.

The HAL marker generator is a frequency divider requiring 3 vdc which can be arranged to provide 25 khz or 50 khz markers from a 100 khz crystal calibrator. For $4.95 it is shipped wired and tested with complete installation instructions.

● International Crystal Mfg. Co., Inc., 10 N Lee, Oklahoma City OK 73102.

● Jan Crystals, 2400B Crystal Dr., Ft. Myers FL 33901.

● Midwest Crystal Company, 1516 Parkwood Road, Cleveland OH 44107.

● Paxitronix Inc., Box 1038 (B), Boulder CO 80302.

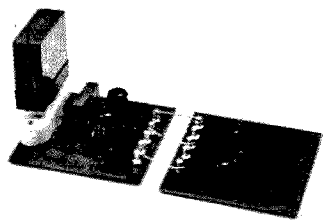
Gives you 25 khz markers from your 100 khz calibrator. Circuit board, $6.25 pp.

● Quaker Electronics, Box 215, Hunlock Creek PA 18621.

● The Radio Shop, 48 Elm St., New Canaan CT 06840.

Frequency marker kit, PC board, uses your 100 khz crystal, outputs on 100, 50, 25, 10 and 5 khz multiples up to 50 mhz, $15.00 pp.

● R & R Electronics, 311 E. South Street, Indianapolis IN 46225.



Crystal calibrator 100 khz, kit, PC board, battery operated, with crystal, $5.

Calibrator kit for 25 khz and 50 khz markers, harmonics to 50 mhz, $8.

● Sentry Manufacturing Co., Crystal Park, Chichasha OK 73018.

Precision quartz crystals and electronics for the Communications Industry.

● Nat Stinnette, Drawer Q, Umatilla FL 32784.

Desks

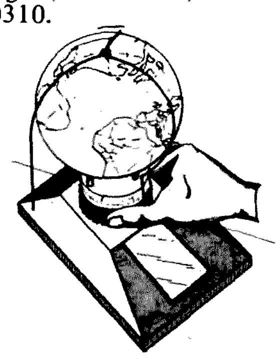
● Design Industries, Inc., Box 19406, Dallas TX 75219.

DX

● Global Computations, Box 2245, Rockville MD 20852

Beam headings computed for any place in the world. Send $4 with exact location and get a great circle bearing to over 500 locations, distance in miles or kilometers (please advise), return bearings, call-sign prefix and time difference for each location. If you can't give your latitude and longitude, add .50.

● Megart, Box 2097, Des Moines IA 50310.



Globe plotter, small globe mounted to indicate bearing from your station to any part of the world. Reciprocal bearing can be found easily too, clever invention, $18 pp.

● Montgomery Geodetic Services, Box 5707, Bethesda MD 20014.

● World QSL Bureau, 5200 Panama Avenue, Richmond CA 94804.

The only QSL Bureau in the USA to handle for a fee outgoing QSLs to anywhere in the world including intra USA, Canada, and Mexico. Bureau operates in accurate, efficient manner, and has use of computers, postal stamping machines and mechanical equipment. Majority of QSLs are sorted, processed and mailed out within 48 hours of receipt. See page 131 for details.

● 73 Atlas, 73 Magazine, Peterborough NH 03458.

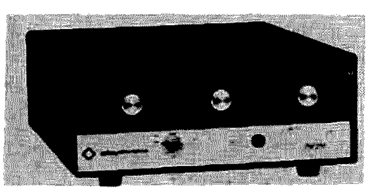
Engravers

● Arnold's Engraving, 2041 Linden St., Ridgewood NY 11227.

Personalized on the air sign, lights up, $12.95. Engraved tie call bars, station call plates, call pins.

FM

● Galaxy Electronics, 10 South 34th St., Council Bluffs IA 51501.



FM-210 FM transceiver, solid state, FET front end, 12-14 vdc, three channels, squelch, compressor, $199.95 plus $39.95 for a power booster.

● ICE, 8507 Speedway, San Antonio TX 78230.

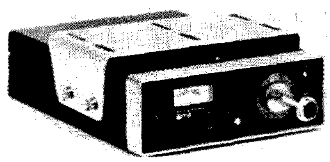
ICE-2 two meters FM transceiver, three channels, built in power supply, 4 watts, $285. ICE-6 six meters, same as ICE-2 otherwise. Nicad battery and charger $47.

● K-N Electronics, Inc., 107 Moorewood Ave., Avon Lake OH 44012.

● Newsome Electronics, 19675 Allen Road, Trenton MI 48183.

Surplus FM equipment, particularly Motorola.

● Standard Communications, Box 3727, Torrance CA 90502

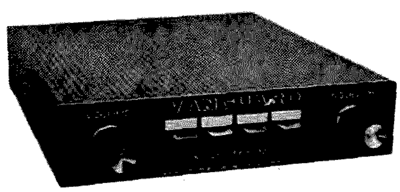


Solid state FM transceiver, 12 channels, 5 watts, $300, 10 watts, $335, both for two meters.

● Two-Way Radio Engineers, Inc., 1100 Tremont St., Boston MA 02120.

Motorola FM schematic digest $3.95 pp. Schematics, crystal information, alignment instructions, service hints.

● Vanguard Electronic Labs, 196-23 Jamaica Ave., Hollis NY 11423.

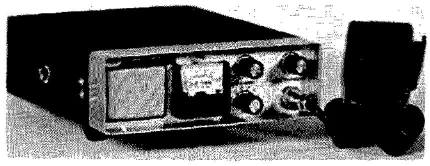


FMR-150 FM monitor receiver. Dual gate MOSFET front end for very low noise, minimum cross-talk, squelch, 12 vdc, four channels $69.95. Plus two and six meter converters.

● Varitronics, Inc., 4109 N 39th St., Phoenix AZ85018.

FDFM-2S two meter transceiver, 10 watts solid state, six channels, 12 vdc, $310. Two watt model $250.

● VHF Associates, Box 22135, Denver CO 80222.



FMT-1 two meter FM transceiver, all solid state, 13.5 vdc, six channels, $289.95.

Keys & Keyers

● Digi-Key, Box 27146, Minneapolis MN 55427.

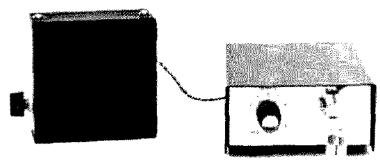
Solid state, 5-50 wpm, self completing, for grid block rigs (optional relay available), $15 pp.

● Electrophysics Corp. 898 W 18 St., Costa Mesta CA.

Autronic Key, $20; Autronic Keyer, $80.

● Global Import Co., Box 246, El Toro CA 92630.

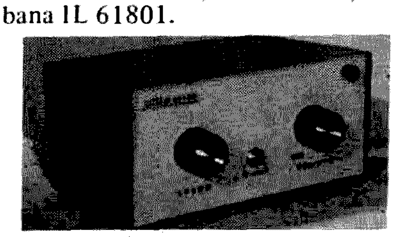
Transkey Senior ($74.50 pp.) is a one unit transistorized keyer with key enclosed in the unit, ac or battery operation, all controls on front panel including speed, monitor tone and volume, semi-automatic or automatic keying, spacing or weight adjustment. Outputs on back include both transistor and relay for operating any type transmitter.



Transkey ($34.95 pp.), electronic keyer and monitor. Relay output, built in key, 5-50 wpm, battery built in or external 6v source, automatic or semiautomatic operation, variable tone monitor, dot-space ratio adjustable, 2 lbs, guaranteed.

● Global Research & Supplies, Box 271, Lombard IL 60148.

HAL Devices, Box 365L, Urbana IL 61801.

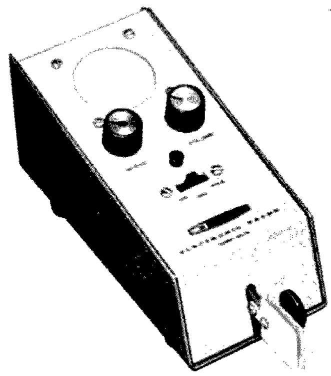


The all new model 311B IC keyer contains all of the features which make the HAL line the most versatile line of keyers available. Offering triggered time base, iambic

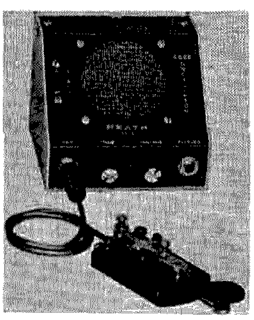
operation with dot memory, monitor with tone and volume controls, regulated AC power supply, 150v/500ma transistor switch for both grid block and cathode keyed transmitters, automatic and semi-automatic operation, and tune up switch, the 311B is completely assembled and guaranteed, $43.95 pp. Other models from $15.00.

● Hallicrafters Co., 600 Hicks Road, Rolling Meadows IL 60008.

● Heath Company, Benton Harbor MI 49022.



HD-10 solid state electronic keyer, 15-60 wpm or 10-20 wpm, self completing dashes, semi-automatic if desired, variable dot-space ratio, side tone and speaker, built in ac power supply, use with grid block keying transmitters, $40.

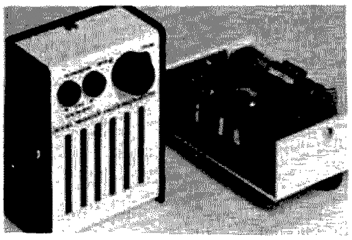


HD-16 code practice oscillator, transistorized, battery operated, with speaker, $10.

● A.T. Hunter, 6201 Jumilla Avenue, Woodland Hills CA 91364.
HDK Digital Keyer, IC built, battery operated, $28.

● Hunter Sales, Inc., Box 1128, Des Moines IA 50311.

● James Research Company, 20 Willits Road, Glen Cove L.I. NY 11542.



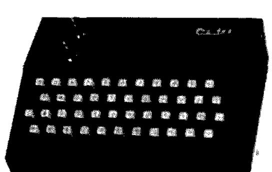
Oscillator/monitor, mark 2, price: $14.95 pp. This versatile product for the CW operator and ham experimenter is a super-sensitive rf type of CW monitor, a code practice oscillator, and rf tester, and a non-destructive component continuity and semiconductor tester. It features a 4 transistor 2 diode circuit, a single AA cell for power, and a rugged black and silver anodised aluminum cabinet.

Permaflex Key, price: $19.95 pp. This twin lever key is for use with modern high speed electronic keying circuits. It also converts to a straight hand key for slow speed CW. The independent fibreglass paddles flex to make contact, have adjustable gap and tension, and are fully enclosed in a polished chrome plated cabinet. Contacts and conductors are gold plated for high reliability.

● M & M Electronics, 6835 Sunnybrook NE, Atlanta GA 30328.

Dah-Ditter model EK-1, electronic keyer to 40 wpm, solid state, self-completing with 3/1 ratio, ac powered, built in monitor, works with present key or bug, $34.95 pp.

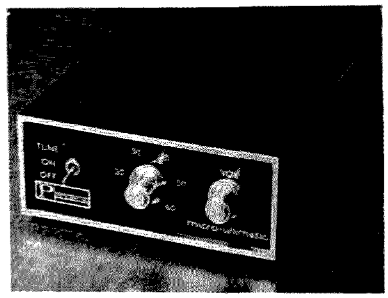
● Micro-Z, Box 2426, Rolling Hills CA 90274.



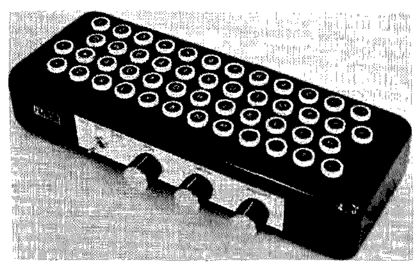
The Pro-Key is an easy-to-assemble kit that provides perfect Morse code from 5 to 50 wpm. When a key is pressed, the character is stored within micro-seconds and cannot be disturbed until complete–permitting you to move on to the next key at your leisure. Completely self contained battery operated, with relay output. Kit includes all parts, pre-assembled keyboard, two printed circuit boards, and detailed, illustrated assembly instructions.

● Palomar Engineers, Box 455, Escondido CA 92025.
IC keyer, all solid state, built in key, fully digital, dot-dash ratio always perfect, keys any circuit up to 100 ma, $67.50. Free brochure.

● Pickering Radio Company, Box 29, Portsmouth RI 02871.



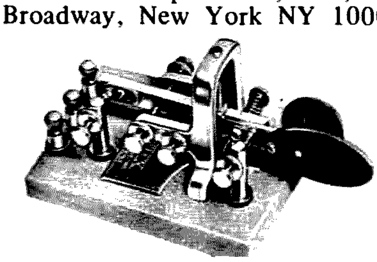
The K-1 Micro-Ultimatic provides dot and dash memories for either conventional or squeeze paddles. 10-60 WPM; internal monitor osc; models for blocked grid or relay output available. One-year warranty, $85.00 FOB.



The ultimate in CW operation. The KB-1 generates any of 47 characters with precision and automatic letter spacing. Press the right buttons; get perfect code. 12-72 wpm; variable weight; internal monitor osc/amp; keys most blocked-grid rigs or external relay. Only 2 x 4 x 10 inches. $265.00 FOB.

● Ten-Tec, Inc., Hwy. 411 E, Sevierville TN 37862.

● The Vibroplex Co., Inc., 833 Broadway, New York NY 10003.



Vibroplex keys, $20.95 to $43.95, including the new Vibro-

keyer for use with electronic keyers, $21.00.

● Waters Manufacturing, Wayland MA 01778.

Codax automatic keyer $98.

Microphones & Preamps

● Caringella Electronics, Inc., Box 327, Upland CA 91786.

Model ACP-1 compressor-preamp kit, 30 db range, FET input, PC construction, adjustable input and output, connected tor PTT, $18.50.

● Heath Company, Benton Harbor MI 49022.

HD-15 phone patch, hybrid, operates VOX and PTT, $25.

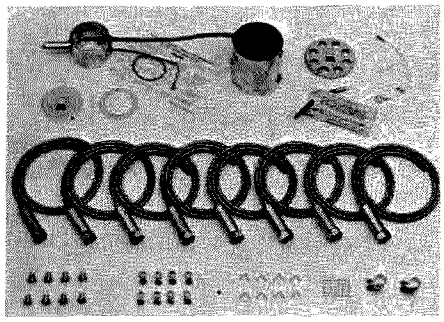
HDP-21 SSB microphone & stand, switch, $29.40

● Waters Manufacturing, Wayland MA 01778.

Hybrid phone patch $55. Patch with Compreamp $76. Compreamp alone $28.

Noise Reduction

● Estes Engineering Co., 543 W 184th St , Gardena CA 90247.



Electro-shield system eliminates ignition noise, custom complete shielding set for any car, $69.95 for eight cylinders, $61.95 for six cylinders. This is the system used for quieting airplanes and is the only way to achieve complete quiet mobile.

Receivers & Converters

● Allied Radio Corp., 100 N Western Ave., Chicago IL 60680.

A-2516 80-10 meter ham band receiver (plus WWV on 10 mhz). Solid state vfo, mechanical i-f filter, preselector, product detector for SSB, crystal oscillator for very low drift, ac operated, $170.

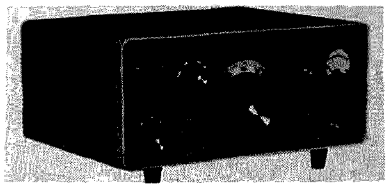
● Ameco, Box 6527, Raleigh NC 27608.

SWL-4 solid state receiver, 540 mhz to 23 mhz in four bands. Model R-5 receiver 540 mhz to 54 mhz in five bands, all solid state with ac supply, $100. R-5 is also available in kit form. Ameco also makes a wide range of converters, solid state and tube, with models for any band.

PV nuvistor preamplifiers for 28, 50, 144, & 220 mhz, also excellent for improving FM two-way equipment, $14.95, each band.

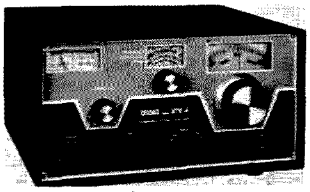
PT preamplifier, covers 6-160 meters, built in power supply, designed to work with SSB transceivers and improve the sensitivity of the receivers, $59.95.

● Collins Radio Co., Cedar Rapids IA.



75S3B receiver, 3.5 to 29.7 mhz amateur bands or any frequency except 5-6.5 mhz in that range with extra crystals, $795.

● Drake Manufacturing, Miamisburg OH 45342.

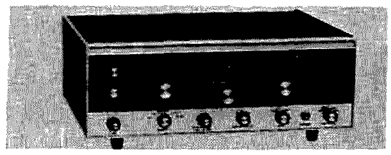


SPR-4 solid state programable receiver. Can be programmed for short wave listening, amateur radio, broadcasting, marine radio, etc. Dual gate FET rf amplifier, 23 500 khz ranges, three bandwidths, high and low freq i-f stages, notch filter, etc. Accessories:noise blanker, calibrator, speaker, loop antenna, transceive adaptor, dc power cord, etc., $379.00. Can handle signals like the best in tube receivers. Extremely stable.

Model 2C receiver, while designed for hamband use primarily, will tune any 500 khz segments from 3-30 mhz. Bandspread calibrated in 1 khz. Selectivity of .4, 2.4, and 4.8 khz, $230. Accessories available: speaker, $20; Q-multiplier/speaker, $40; calibrator, $17.

Model R4B receiver, covers 500 khz segments from 1.5 to 30 mhz. 1 khz calibration. Will transceive with T4XB transmitter. .4, 1.2, 2.4, and 4.8 khz selectivity. Built in noise blanker, calibrator, notch filter, $430.

● Galaxy Electronics, 10 South 34th St., Council Bluffs IA 51501.



R-530 solid state receiver, 0.5 to 30 mhz, 1 khz dial, 50 khz calibratoı, noise blanker, $695. Speaker, $40. Receiver has 2.1 khz passband, other crystal lattice filters, $45 for 500 hz, 1500 hz and 6 khz.

● Hallicrafters Co., 600 Hicks Road, Rolling Meadows IL 60008.

SX-122A receiver, 538 khz to 34 mhz, calibrated bandspread of ham bands, $395; accessory speaker and calibrator, $20.

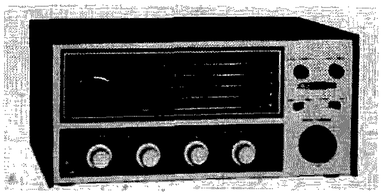
SX-146 ham band receiver, 80-10 meters, accessory calibrator, speaker, and 500 hz filter.

SX-130 general coverage receiver, bc band plus 1.7 to 34 mhz in three bands, accessory speaker.

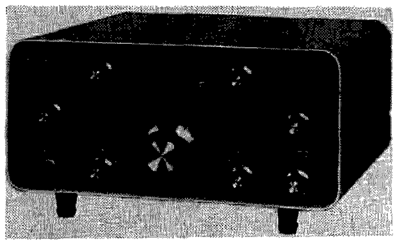
● The Hammarlund Manufacturing Co., Inc., 73-88 Hammarlund Drive, Mars Hill NC 28754.

HQ-215 solid state receiver, covers 80-15 meter ham bands plus 13 more 200 khz segments from 3.4 to 30.2 mhz. Also covers 28.5-28.7 mhz. 2.1 khz selectivity with supplied filter, $400.

● Heath Company, Benton Harbor MI 49022.



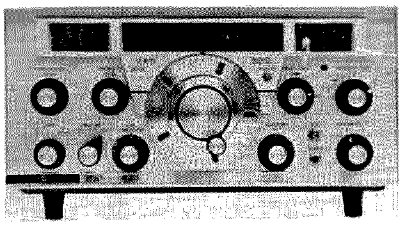
HR-10B receiver, 80-10 meters, ham bands only, $80. Calibrator, $9.



SB-301 amateur band receiver, I khz dial, calibrator built in, $260. AM or CW crystal filters, $21. Six or two meter converters, $20.

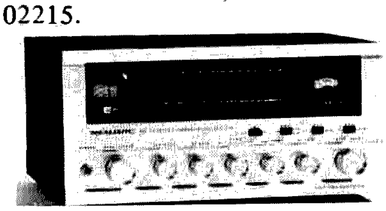
● Lafayette Radio Electronics, Box 10, Syosset, L.I. NY 11791.

● National Radio Company, Inc., 37 Washington St., Melrose MA 02176.



HRO-500 solid state receiver, 5 khz to 30 mhz, 1 khz dial, $1675. Speaker, $40. Tunes in 60 bands of 500 khz each, continuous coverage. 50 khz calibrator built in.

● Radio Shack Corp., 730 Commonwealth Ave., Boston MA 02215.

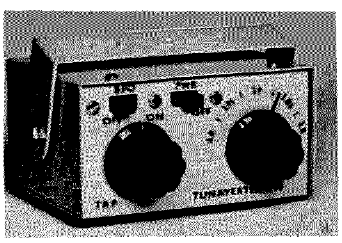


DX-150 all wave receiver. Tunes dc band, plus three short wave bands to 30 mhz, $120. Matching speaker, $8.

● Herbert Salch & Co., Woodsboro TX 78393.

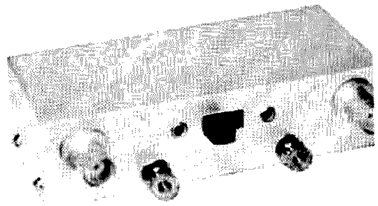
Pro line converters, crystal controlled single frequencies, any two between 108-175 mhz, squelch, $40 with one crystal, $45 with two.· 12v.

SC line converters, single frequency from 26 to 250 mhz, 12v., $25. Weather converter for 162.55 mhz $20. Squelch accessory $18.



X line converters, tunable, 9v., $33. Can be crystal controlled also. Squelch unit $18 extra. Models cover 150-164, 33-48, 118-128, 144-148, 50-54, and 26.9-30 mhz. See ad on page 21, March 1969 issue of 73.

● Vanguard Labs, 196-23 Jamaica Avenue, Hollis,NY 11423.



Model 407 six meter dual gate MOSFET, $35, same for two meters.

3/4 meter converter, three dual gate MOSFETs, $50, 10 meter output. Send for the free catalog of preamplifiers and converters from Vanguard, state of the art in VHF.

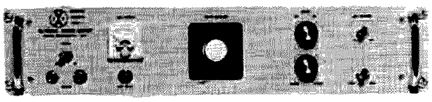
● VHF Associates, Box 22135, Denver CO 80222.

● Westcom Engineering, Box 1504, San Diego CA 92112.

Noise blanket for use with most receivers, transceivers, $29.50

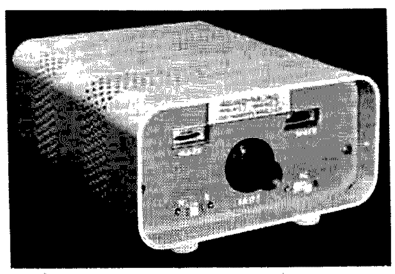
RTTY

● Alltronics-Howard, Box 19, Boston MA 02101.



Teletype equipment, printers perforators, reperforators, polar relays, distributors, accessories, and converters.

● Aquadyne, Box 175, East Falmouth MA 02536.



RTY3 converter, 850/425/175 hz shifts, 3 stage filter, loop supply incl., $140. RTY3SB tuned for use with SSB transceivers, $180. RTY3K, same as RTY3, but built in AFSK generator, $160.

● Essco, 324 Arch Street, Camden NJ 08102.

Solid state RTTY demodulator, single channel, incl. loop supply $132.25, kit. Dual channel unit, kit, $138.25. Factory wired single channel $156.25. Wired dual channel $163.

● Tuck Electronics, 2331 Chestnut Street, Camp Hill PA 17011.

RTTY terminal equipment, solid state, modules, etc.

Surplus

Aerospace Electronics, Box 48-495, Miami FL 33148.

Alvaradio Industries, 3101 Pico Blvd., Santa Monica CA 90405.

Amber Industrial Corp., Box 2129 So. Sta., Newark NJ 07114.

Anker Electronics, 1617 S Main St. & Anker Rd., Wilkes-Barre PA.

ARC Sales, BOx 12, Worthington OH 43085.

Arcturus Electronics, 502 22nd St., Union City NJ 07087.

Arrow Sales Chicago Inc., 2534 S Michigan Avenue, Chicago IL 60616.

Atlantic Surplus Sales, 250 Columbia St., Brooklyn NY 11231.

Barry Electronics Corp., 512 Broadway, New York NY 10012.

B & F Enterprises, Box 44, Hathorne MA 01937.

Bigelow Electronics, Box 71, Bluffton OH 45817.

Brigar Electronics, 10 Alice St., Binghamton NY 13904.

C. & H. Sales Co., 2176 E Colorado St., Pasadena CA 91107.

Columbia Electronics, 4365 W Pico Blvd., Los Angeles CA 90019.

Communication Sales Co., 7231 Hinds Avenue, N. Hollywood CA 91605.

Cornell Electronics, 4205 University Avenue, San Diego CA 92105.

Ted Dames Co., 308 Hickory St., Arlington NJ 07032.

Denson Electronics, Box 85, Rockville CT 06066.

Dow Trading Co., 1829 E Huntington Dr., Duarte CA 91010.

Fair Radio Sales, Box 1105, Lima OH 45802.

Gadgeteers Surplus Electronics, 5300 Vine Street, Cincinnati OH 45217.

Gateway Electronics Corp., 6150-52 Delmar Blvd., St. Louis MO 63112.

G & G Radio, 77B Leonard, New York NY 10013.

J. J. Glass Co., 1624 S Main St., Los Angeles CA 90015.

Goodheart Co., Box 1220, Beverly Hills CA 90213.

Hayden, Box 294, Bay St. Louis MS 39520.

Jan Crystals, 2400 Crystal Drive, Fort Myers FL 33901.

J. & H. Outlet, 476 Industrial Way, San Carlos CA 94070.

Jefftronics Unlimited, 4252 Pearl Road, Cleveland OH 44109.

Jennings, 2730 Chanticleer Ave., Santa Cruz CA 95060.

Jet Crystal Co., 1718 W Lomita Blvd., Lomita CA 90717.

Liberty Electronic, 548 Broadway, New York NY 10012.

Mazer Enterprises, 17740 Bay Circle, Fountain Valley CA 92708.

Mendelson Electronics Co., 516 Linden Avenue, Dayton OH 45403.

Meshna, 19 Allerton St., Lynn MA 01904.

Military Electronics Corp., 4178 Park Avenue, Bronx NY 10456.

Norman Electronics Sales, 1413 Howard Street, Chicago IL 60626.

North American Electronics, Box 878, Plattsburgh NY 12902.

Park Electronics, Box 78, N.Salem NH 03073.

Poly Paks, Box 942A, Lynnfield MA 01942.

Quaker Electronics, Box 215, Humlock Creek PA 18621.

Mike Quinn Electronics, Electronics Bldg., 727 Langley St., Oakland Airport CA 94614.

R & R Electronics, 247 S Meridan St., Indianapolis IN 46225.

Relay Sales, 2400 Crystal Drive, Fort Meyers FL 33901.

Selectronics, 1206 S Napa St., Philadelphia PA 19146.

Slep Electronics Co., Drawer 178, Ellenton FL 33532.

Solid State Sales, Box 74, Somerville MA 02143.

Surplus Specialities, Box 118, Pittsfield MA 01203.

TAB, 56 Pearl St., Brooklyn NY 11201.

United Radio Co., 56 Ferry Street, Newark NJ 07101.

Unity Electronics, 107 Trumbull Street, Elizabeth NJ 07206.

Test Equipment

● Clemens Mfg. Co., 630 S Berry Rd., St. Louis MO 63122.

● Heath Company, Benton Harbor MI 49022.

HM-15 SWR meter, 160-6 meters, 1 kw, 50 or 75 ohms, $15.

HM-10A tunnel dipper, 3-260 mhz, battery operated, $30.

HN-31 Cantenna dummy load, 1.5 to 300 mhz, 50 ohms, 1 kw, $10.

HD-20 100 khz calibrator, to 54 mhz, battery operated, $15.

PM-2 100 khz to 250 mhz rf field strength meter, $13.

● Lampkin Laboratories, Inc., Bradenton FL 33505.

● Omega-T Systems, Inc., 300 Terrace Village, Richardson TX 75080.

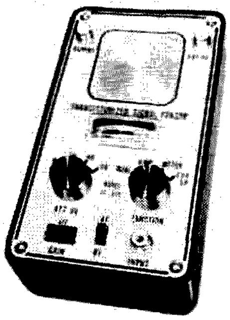
● Paxitronix, Inc., Box 1038, Boulder CO 80302.

● Quement Electronics, Box 6000, San Jose CA 95150.

● Radio Shop, 48 Elm St., New Canaan CT 06840.

● Redline Company, Box 431, Jaffrey NH 03452.

Mini-lab, ten test instruments in one, VOM, rf sig gen, af sig gen, resistor and capacity substitution, rf field strength, self powered, $25 pp.



Signal tracer model SE350, signal strength meter, output speaker, rf and af amplifiers, measure gain of any rf or af stage, self powered, $23.50 pp.

Miniature AF signal generator, laboratory grade, ac powered, 10-100,000 hz, $60 pp.

● Spectrum Ltd, 245 Gregg Ct, Los Gatos CA 95030.

390-900 mhz frequency meter, indicates down to 2 microwatts, 500 ua meter, $39.50 pp. With built in 100 ua meter, $1.50 additional.

● Syntelex, 39 Lucille, Dumont NJ 07628.

SDA solid state decade amplifier converts VOM or VTVM into a sensitive audio and i-f milivoltmeter or use as preamp for counter, scope, etc., $35 pp.

● The Technical Materiel Corp., 700 Fenimore Road, Mamaroneck NY 10543.

● Waters Manufacturing, Wayland, MA 01778.

Dummy load wattmeter 1 kw $135. 1500 watt $145. Dummy load $65.

Towers

● Dura Tower Sales, Box 322, Angola IN 46703.

Tilt-up and tilt-over steel towers; tilt up to 50', and tilt-over to 90'.

● Gateway Towers, 7530 Big Bend Blvd, St. Louis MO 63119. Free standing, crank up, crank up–tilt over, free standing-tilt over, free standing-fold over towers of aluminum.

● Heights Mfg. Co., 4226 Maybury Grand, Detroit MI 48208.

Self-supporting tapered aluminum crank-up and fold-over towers.

● Microflect Towers, 3575 25th Street SE, Salem OR 97302. Light weight aluminum towers to 120 feet high in 10 foot sections. 12-1/2 lbs per section. Staggered ladder treads for easy climbing.

● Rohn, Box 2000, Peoria IL 61601. Largest manufacturer of steel towers. Hot dipped galvanized towers of all kinds: free standing, guyed, tilt over, etc.

● Tri-Ex Towers, 7182 Rasmussen Avenue, Visalia CA 93277. Steel towers. Crank up, self supporting, guyed, rotating.

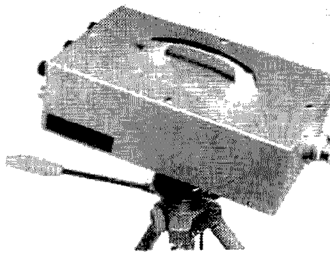
● Tristao Towers, 415 E 5th Street, Hanford CA 93230. Self supporting and guyed crank up towers of galvanized steel and self supporting crank up mini-masts.

● Universal Manufacturing, 6017 E McNichols, Detroit MI 48234. Free standing aluminum towers. Towers to 90 feet.

● Vesto, 1916 Clay Street, Kansas City MO 64116. Self supporting steel towers.

TV

● ATV Research, 13th & Broadway N, Dakota City NB 68731.



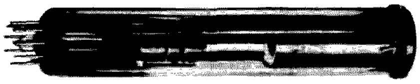
Build it yourself solid state vidicon cameras, accessories, modules, lenses, instructions. Camera kits as low as $117. Video module, $20. Vert. module, $15. Horiz. module, $15. RF osc module, $10. HV module, $10. Free details.

● Denson Electronics, Box 85, Rockville CT 06066.

Used cameras, TV crystals, vidicons, accessories, lenses, gadgets, send for free flyer and be amazed. World's largest collection of TV stuff.

● GBC, 74 Fifth Avenue, New York NY 10011.

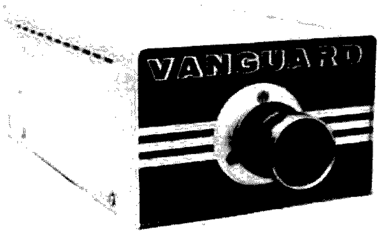
Video tape recorders, vidicons, etc.



Vidicon; Hitachi 7038H, $29.50;

Hitachi 7735A, $34.50; Hitachi 7262, $34.50 (replacement for Sony and Panosonic); Hitachi 8507, $74.50 (Separate Mesh).

● Vanguard Labs, 196-23 Jamaica Avenue, Hollis NY 11423



Television camera, complete, great for closed circuit TV, ham TV, $280.

Camera kit, including vidicon and lens, $100.

Transmitters, Transceivers & Linears

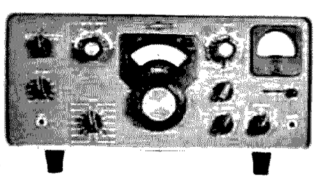
● Aerotron, Inc. (Ameco), Box 6527, Raleigh NC 27608.

AC-1 Novice CW transmitter, 40-80 meters, kit. TX-62, six and two meter phone-CW transmitter, 75W, $160. VFO-621, vfo for use with any VHF transmitter, $70. GSB6, Gonset six meter SSB transceiver, 20 watt PEP. Gonset 903 linear amplifier, two meters, 500 watts PEP. 913 linear amplifier, six meters 500 watts PEP. Communicator IV, six meters, transceiver, 20 watts input.

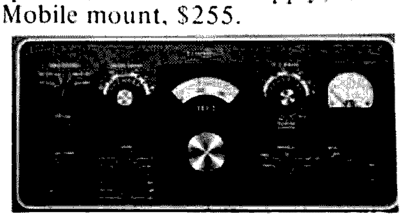
● Allied Radio Corp., 100 N Western Ave., Chicago IL 60680.

TR-106 six meter transceiver, 15 watts input, $90. V-107 VFO kit, six and two meters, $25. T-175 six or ten meter linear amplifier 330 watts PEP on SSB, 120 watts AM, $100.

● Collins Radio Co., Cedar Rapids IA



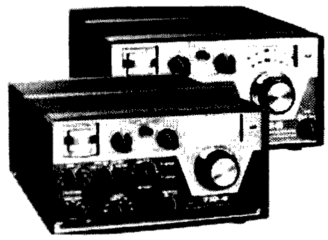
KWM-2 transceiver, 175 watts PEP, 80-10 meters, $1150. AC supply, $153. PTO, wattmeter, patch, speaker, $350. DC supply, $235. Mobile mount, $255.



32S3 transmitter, 175 watts PEP, same range as 75S3 receiver, $865.

30L1 linear amplifier, 1000 watts PEP, 80-10 meters, $520.

● Drake Manufacturing, Miamisburg OH 45342.



TR-4 SSB transceiver, 80-10 meters, 300 watts PEP, solid state vfo calibrator, 1 khz dial, CW sidetone, $600.

TR-6 six meter SSB transceiver, 300 watts PEP, calibrator, $600.

2NT 100 watt CW transmitter, 10-80 meters, $150. L-4B linear amplifier, 2000 watts PEP, 80-10 meters, two 3-500Z tubes, $750.

TR44B, R4B and T4B in one case, $850.

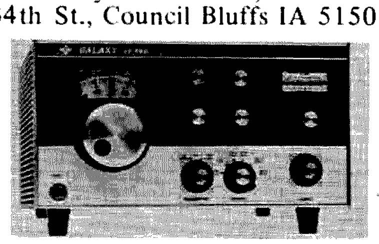
T4XB 200 watt transmitter PEP, 80-10 meters or any 500 khz range between 1.8 and 30 mhz. Covers 160M with accessory crystal, $450.

TC-2 180 watt transmitting two meter converter, $300.

TC-6 six meter transmitting converter, $250.

C4 station console includes clock, timer, patch, wattmeter, rotor control, etc. $300.

● Galaxy Electronics, 10 South 34th St., Council Bluffs IA 51501.

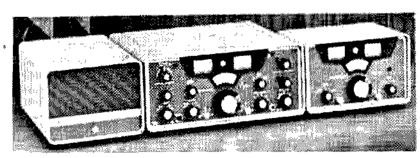


GT-550 SSB transceiver, 550 watts PEP, 80-10 meters, $475. Accessories: RV550 remote vfo, $75; RF550 rf console, $69; SC550 speaker, $25; LA550 linear amplifier 200 watts PEP, $495; PR550 patch, $49; DC supply, $125; AC supply, $90; Calibrator, $25 (25 khz); CW filter, $30; VOX, $30.

● Hafstrom Technical Products, 4616 Santa Fe, San Diego CA 92109.

LK2000, 2000 watt PEP linear, $795. LK2000HD, 3000 watt PEP linear, $895. RF2000, table top rf section only, $595. PS2000 power supply, $300. Heavy duty PS3000 supply, $400. DL2000 dummy load, $75.

● Hallicrafters Co., 600 Hicks Road, Rolling Meadows IL 60008.



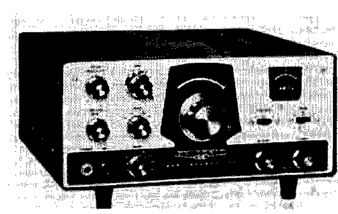
SR400 Cyclone transceiver, 80-10 meters, 400 watts PEP, $800. AC supply PS500A-AC, $130. P500DC supply, $160.

SR2000 Hurricane transceiver, 80-10 meters, 2000 watts PEP, $1095. P2000 AC supply, $450.

HA20 VFO/VSWR console for 400 or 2000, $200.

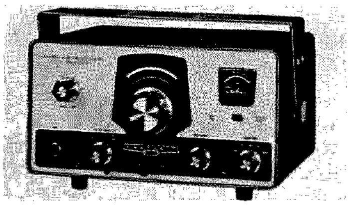
● The Hammarlund Manufacturing Co., Inc., 73-88 Hammarlund Drive, Mars Hill NC 28754.

● Heath Company, Benton Harbor MI 49022.

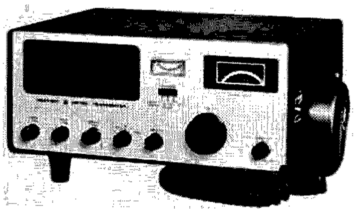


HW-100, 80-10M transceiver (SSB), 180 watts, $240. Speaker, $19. DC supply, $65. AC supply, $50.

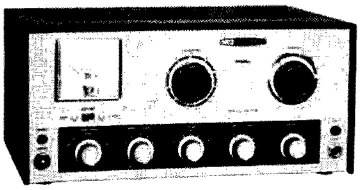
HW-12A, 80M SSB transceiver, 200 watts PEP, $100. HW-22A, 40M transceiver, $105. HW-32A,



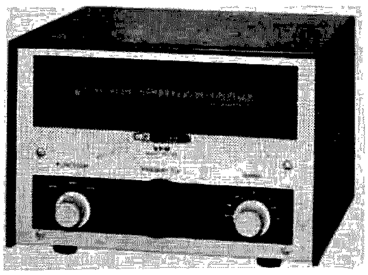
20M transceiver, $105. Calibrator, $9. Microphone, $8.50. DC and ac supplies same as above.



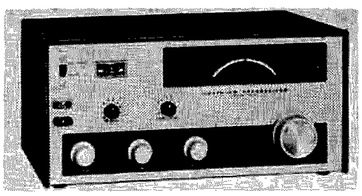
HW-17 2M AM transceiver, 25 watts input, $130. DC supply, $25.



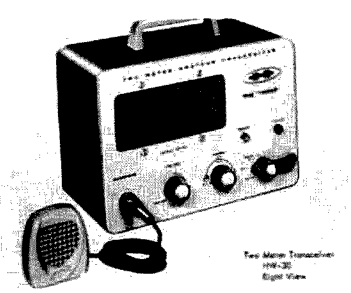
DX-60B transmitter, 90 watts, 80-10 meters, phone or CW, $80.



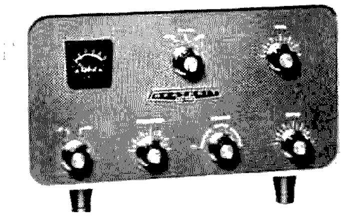
HG-10B VFO for use with DX-60, HW-16, etc., 80 thru 2M calibration, output 3.5-4, 7-7.425, and 8-9 mhz ranges, $40.



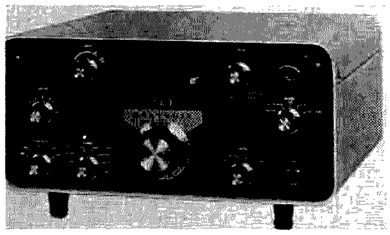
HW-16 CW transceiver, covers first 250 khz of 80-40-15 meters (Novice), 75 watts input, $110.



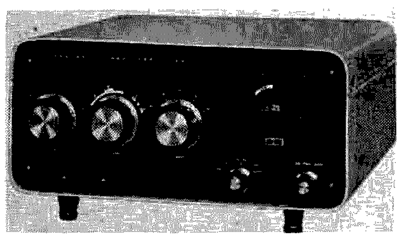
HW-29 six meter transceiver, AM, 5 watts, crystal controlled, super regen receiver, $45. HW-30, same, only for two meters. Mobile power supply, $18.



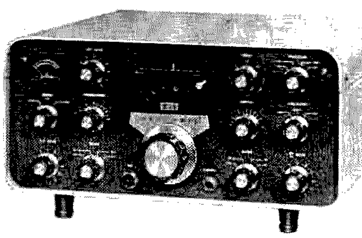
SB-500, two meter transmitting converter for SSB, used with existing 6 or 10 meter SSB transceiver, 140 watts PEP, $180.



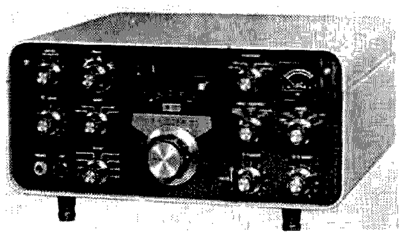
SB-401 SSB transceiver, 80-10 meters, 180 watts PEP, 1 khz dial, will work with Heath SB-301 receiver, built in power supply, $285.



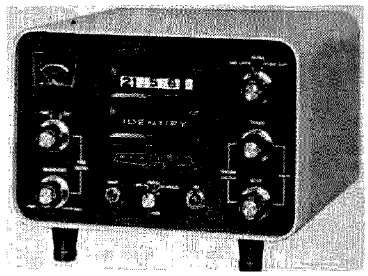
SB-200 matching linear amplifier, 1200 watts PEP, built in power supply, $220.



SB-110A, six meter SSB transceiver, 180 watts PEP, $299.

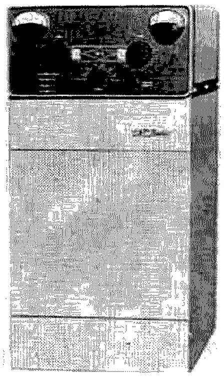


SB-101, 80-10 meters, 180 watts PEP, SSB transceiver, 1 khz dial, WCW sidetone, $370.



SB-630 station console, digital clock, swr meter, patch, timer, etc., $75.

● Henry Radio Stores, 11240 W Olympic, Los Angeles CA 90064.



2K-3 linear amplifier, 80-10 meters, 2000 watts PEP (plus), $745, complete with power supply. Can be driven with most SSB transceivers.

3K linear amplifier, 80-10 meters, continuous 1 kw input duty (or more) for RTTY, etc., $895. Power supply built in. Either linear available in console or desk models.

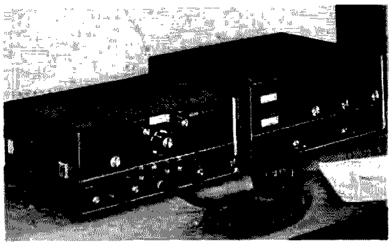
● Hunter Sales, Inc., Box 1128, Des Moines IA 50311.

Bandit 2000C, linear amplifier, five bands, kit form, 2000 watts PEP

● Lafayette Radio Electronics, Box 10, Syosset, L.I. NY 11791.

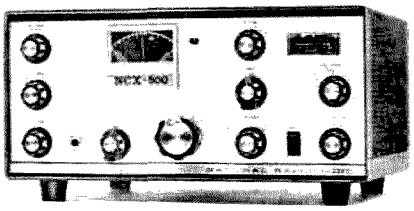
● Linear Systems, Inc., 220 Airport Blvd., Watsonville CA 95076.

SB-34 SSB transceiver, 80-15 meters, $450. SB2-LA linear amplifier, $260. SB3-DCP, dc power inverter for mobile operation (SB-34 has ac power supply built in and is solid state except for power stages).

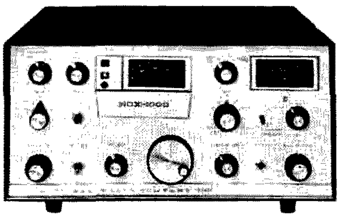


VOX unit, $38. 25 khz calibrator, $29. Microphone, $15.

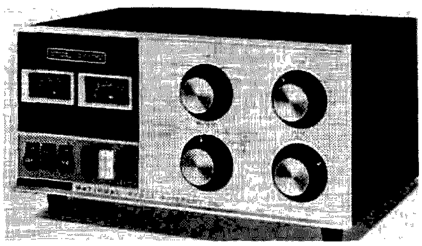
• National Radio Company, Inc., 37 Washington St., Melrose MA 02176.



NCX-500, 80-10 meter SSB transceiver, 500 watts PEP, $425. AC power supply, $99. AC supply/speaker console, $110. 100 khz calibrator, $26.60.



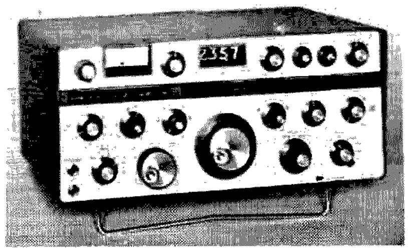
NCX-1000, 80-10 meter SSB transceiver, 1000 watts PEP, all solid state except power stages, $995.



NCL-2000 linear amplifier, $685, complete with power supply.

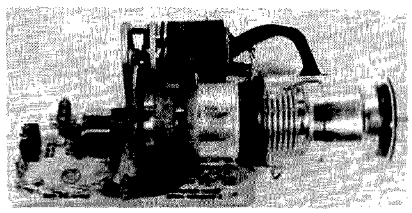
• RF Communications, Inc., 1680 University Avenue, Rochester NY 14610.

• Signal One, 2200 Anvil St. N, St. Petersburg FL 33710



CX7 deluxe integrated station, solid state, 10-160 meters, 100 hz frequency readout, dual VFO's, ac supply built in, 300 watts, noise blanker, etc., $1600 (or more).

• Slep Electronics, 2412 Highway 301N, Ellenton FL 33532.



Jennings variable capacitors for linears, 10-300 pf 7500v, $32.50 pp. complete with gear drive train, mounting bracket.

• Spectronics, Box 356, Los Alamitos CA 90720.

FTDX400 transceiver, 25 khz calibrator, 80-10 meters, 500 watts PEP, sidetone, offset tuning, $600. Speaker $15.

FTDX2000 linear amplifier, 1200 watts PEP, SWR bridge built in, solid state power supply, $250.

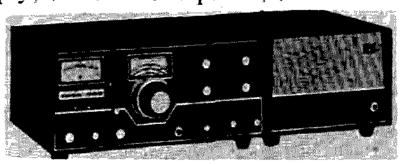
FVDX400 vfo for use with transceiver for split frequency operation, $100.

• Swan Electronics Corp., 417 Via Del Monte, Oceanside CA.

260 Cygnet 260 watts SSB transceiver, built in ac/dc supply and speaker. 80-20-15-10 meters, $435.

270 Deluxe Cygnet 80-10 meters, $525. 508 external vfo, $125. Linear amplifier, including ac power supply, 1200 watts, for 270 and 260, $295.

500C SSB transceiver, 80-10 meters, 520 watts PEP, $520. AC supply with speaker, $105. DC supply, $130. Phone patch, $28.



350C transceiver, similar to 500C except no calibrator, sideband switching, ANL, etc., $420.

250 six meter SSB transceiver, 240 watts, $420.

Mark II Linear amplifier, 2000 watts PEP, $395. Power supply, $235.

• VHF Associates, Box 22135, Denver, CO 80222.

STICKY RELAY CONTACTS

I bought a new Dow-Key antenna relay for my Heath Seneca VHF-1 transmitter, and experienced a problem with the relay contacts sticking when the function switch was returned to the stand-by position. The trouble was that the Seneca was emitting a signal before the antenna relay contacts had closed and thus the contacts arced and welded together.

The problem was solved by utilizing the "Remote Control" terminals on the octal socket on the back panel of the Seneca. I just wired these contacts into the external contacts on the antenna relay so that the remote control terminals were shorted only after the relay had closed, thus preventing the Seneca from transmitting before the relay had closed. No futher trouble was experienced with sticking antenna relay contacts.

This same trick may be used with any transmitter using a relay for antenna switching, as long as the antenna relay has two normally open contacts. If the transmitter does not have several contacts that must be closed before the transmitter will transmit, the keying terminals may be used in the same manner; just make sure that the keying terminals must be shorted before the transmitter will transmit, and then wire the terminals into the antenna relay's external contacts.

Steve Harrison WB6PKA

SEXtupler Corrections

Page 62, November, 1969, Fig. 4. The filament transformer primary should connect between the filament switch and the hv switch and should not be black-dotted to short out the line. The left side of the time delay switch should not be black-dotted to the lower line. As shown the circuit is more of an acme fuse tester than a SEXtupler.

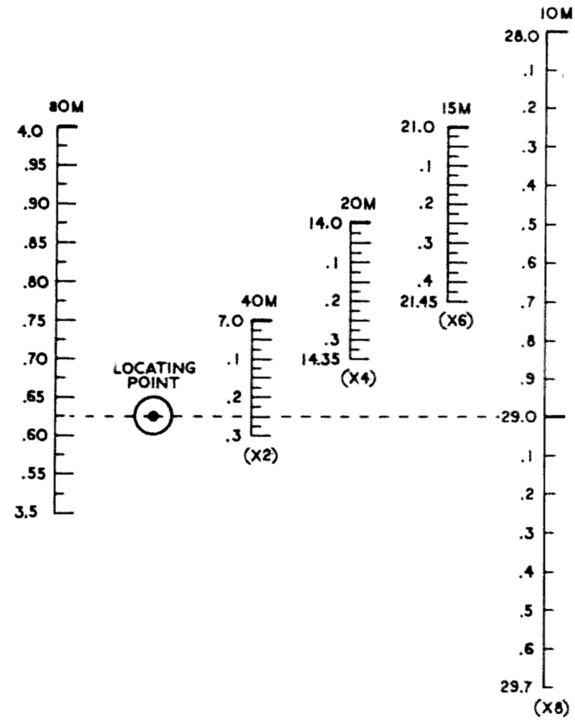
Low-Band Nomograph

How many times have you picked up a 40 meter crystal and wondered whether or not it was usable on 10 meters? Or, how about the times you wanted to check for spurious radiations on other bands when you were on 80 meters? In such cases, you got out the pencil and paper and started multiplying the crystal frequency by different multipliers until you arrived at the answer you were looking for.

Well, here is a nomograph which takes a considerable amount of the figuring out of it. By laying a straightedge from your 80 meter crystal frequency through the locating point, you can tell at a glance whether the same crystal is usable on another band. At the bottom of each band, the correct multiplier, with reference to the 80 meter crystal frequency, is also shown.

Additionally you can check whether or not a crystal is usable on a higher frequency band by laying a straightedge through the frequency and the locating point. If the multiplier of the lower band is an integer and not a fraction, then it is usable and a glance will show the approximate frequency.

The dotted line shown on the nomograph serves as an example. An 80 meter crystal marked 3.625 mhz will produce harmonics on both 40 meters and 10 meters at approximately 7.25 mhz and 29.0 mhz respectively. Additionally, of course, it shows that by using a quadrupler and doubler or three doubler stages (X8), you could use the 80 meter crystal on 10 meters. One step further says that if you had a 40 meter crystal marked 7.25 mhz, a quadrupler stage or two doubler stages would provide a 10 meter



frequency at 29.0 mhz. The (X8) multiplier divided by the (X2) multiplier gives the required multiplication of (X4).

So replace that pad and pencil with a straightedge for those quick answers when you don't need to know a precise number. Think of the time for rag-chewing you might pick up. ... E. R. Davisson K9VXL

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters have been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

(continued from page 4)

Contest buffs detest net personnel. Phone operators constantly denigrate CW practitioners. RTTY fans demean phone patchers. VHF men have contempt for low band operators. AM boys are revolted by SSB'ers. Designers and constructors hate "appliance operators." Technicians distrust all higher grade licensees. Old timers resent "Johnny-come-latelies." Youth maligns age. And so forth, and so on, ad infinitum.

Is it any wonder that in the world at large, where the divisions are even more marked, there are irreducible tensions and schisms? Is it so strange that human society suffers constantly from the syndromes of fear, distrust and hatred, since the stakes are so much higher . . . life or death; destruction or survival. The microcosm reflects the macrocosm, does it not?

Whatever your persuasion, or even if you have none at all, one thing you must grant. It took a Roman Catholic Prelate to make the most meaningful attempt, to date, to overcome this universal problem. Pope John XXIII was the one individual who actually formulated a viable modus operandi, through which some progress might eventually be made. I am speaking of Ecumenism. This is the key to everything. This is the foundation stone upon which an indestructible bastion of unity may finally be built.

This is true of differing faiths and nations. And it is no less true of all sorts of contending factions, no matter how small, no matter how trifling in the larger scheme of things. The spirit of Ecumenism, if applied to situations where contentiousness and angry confrontation exist, may overcome all these problems, when all else has fallen short.

Well, how about us? How about the constant intra-mural tensions in ham radio? Are they piddling little differences of no concern? Are they unimportant trifles which do us no injury? Are they mere annoyances, to be tolerated with a shrug of insouciant resignation? Shall we continue to say, "That's the way of the world. That's human nature, and you'll never change it"?

In my judgment is is still not too late. I believe that these differences are still too small and unimportant to outweigh the positive areas in which we all see eye to eye. But the world is changing fast, and extreme positions are polarizing rapidly toward even wider and more unbridgeable gulfs. I feel deeply that all of us must seek the means by which to build a mighty sense of solidarity throughout our entire fraternity. I think that if we do not do this, that if we fail to understand that there are strong exterior forces, bent on compromising or destroying our privilege, we may find ourselves becoming witnesses to the death agonies of Amateur Radio as we know it, and as we would like to see it remain.

Let's not forget that great slogan of the early American colonists, "United we stand . . . Divided we fall."

* * *

I've just written a letter to FCC Chairman Nicholas Johnson, concerning a recent appearance on network television, in which he made some allegations with which I totally disagree. I took the additional opportunity, since I was also disturbed over other matters with respect to Amateur Radio, to give voice to some opinions shared by many of you. While there are those who will feel that any individual expression of ideas to the FCC would tend to be inimical to the cause of our hobby, in my view there has been ample precedent for this. When ARRL communicated with FCC in this self-same manner, urging the adoption of Incentive Licensing, it was clearly an exercise of this type of unilateral contact. Yet, I do not seem to recall any prior discussion in the pages of QST with respect to the forthcoming changes that the League was about to propose. The discussion occurred afterwards . . . and how! On the air, in magazines like this one, in private conversation . . . yes! There was surely plenty of discussion; but not in QST. There, excepting for a few letters from dissident and clearly benighted ignoramouses, all such discussion was conspicuous by its utter absence.

About my letter to Johnson itself; there isn't anything in it that has not appeared in these monthly journals of mine. I told the Chairman exactly how I and tens of thousands of licensees feel about the past year of re-structure. I told him what I and the others think of the second phase, and what it will mean in terms of our good and welfare. This, despite objections from those who feel differently, is not "making waves." It is merely an exercise of that peculiarly unique American birthright, good old Freedom of Speech.

The most important thing; I urged him to see to it that FCC hold public hearings, *whenever* any changes in structuring are contemplated. If ever the Commission should decide to consider *any* change in *any* area of the licensing structure, there should be as wide and open a discussion as possible, with all interested and concerned parties participating; not merely one group which alleges that it speaks for everybody.

I cannot see any possible objection to such public hearings. At least, all views would be heard, and a fair, objective, impartial body of fact would emerge, thus enabling the Commission to deliberate in a much more intelligent and representative fashion.

* * *

More people are complaining about TV commercials these days. This is one of the fastest growing topics of discussion on the bands. Since my business is writing a sort of doggerel, I've decided to register my comments in the disreputable and rather gauche manner of my craft. I will not, however, set it to music. I write *good* songs.

Ode to TV

Banal, revolting nauseating box,
A plague, a pest, foul pestilence, a pox,
A smell, a stench, an odor rank and ripe,
Dull, crashing bore, insufferable tripe.

TV brings you high adventure,

Squirt your armpits, soak your denture.
Win a mate who'll share your pillow,
Use SOS instead of Brillo.
Revlon for your fingernails
Enden for your dandruff scales
Maybelline for longer lashes
Unguentine for sunburn rashes
Roto Rooter for a flood
Geritol for tired blood
Kraft for all your midnight snacks
Dingy floors? Use Johnson's wax.
Solid state by Motorola
Liquid state by Pepsi Cola
Wonder Bread to make kids thrive
Groom your hair with VO Five
Switch to this brand, Change to that,
Smoke a thin smoke, smoke a fat.
All up and down the whole damned map
The air is filled with solid crap!

This shallow, vapid, rank inanity
Must deal destruction to our sanity.
I state with validity and lucidity
To hell with audio-video stupidity.

* * *

Almost every foreign amateur radio society provides an outgoing QSL service. I would be the very last to critize the work that QSL bureaus are doing. It is a thankless job, tedious and monotonous. But only half the job is being done.

It seems incredible that ARRL consistently refuses to consider the establishment of an outgoing service, so that our cards might be sent out at a saving of many dollars. The cost of QSL'ing is becoming prohibitive to the average man, who has to work for a living. It is going to rise even higher, according to indications. Postage rates are going to rise again, and it is ridiculous not to avail ourselves of the economy that this type of service could provide.

I suggest that those who find this idea meritorious should write their Directors and ask for his position on the question. Perhaps, if enough hams write and ask about it, there will be more than an ambiguous platitude for an answer.

* * *

There's a little story about a rather crusty, frontier-type United States Senator, who was invited to a very posh Embassy banquet in Washington. The soup was served, and it was scalding hot. The Senator took one spoonful of it, and it burned his tongue so badly that he spit it out, all over the rather amply endowed bosom of his dinner partner, who was the wife of some foreign ambassador. There was stunned silence, and an air of shocked disbelief at his faux pas.

The Senator was non-plussed for only a brief moment. Then he looked around the room and said, "You know, I'll bet some damned fool would've swallowed that stuff."

Well, friends, some damned fools'll swallow just about anything!

Take, for example, some of the letters that crop up in the correspondence section of a certain

periodical. These indicate that the writers have been brainwashed into a belief that anything which emanates from the Newington "fountainhead' must be true, beyond peradventure. There seems to be a precept; an axiom, if you like, amounting almost to an article of faith, that if anything concerning ham radio is published by the League, then it's just got to be so.

The tone of some of these letters is so insufferably pious as to make the gorge rise. These goody-goody boys, fired with all the zeal of a holy crusade, make me want to vomit!

Here are a few examples from recent issues of QST. I need not make too probing an examination of them, for they are fairly transparent. Besides, why denounce them? They're not worth it. We all know about sow's ears and silk purses.

"...incentive licensing is good for...national preparedness."

> Outside of statements to this effect in QST, I cannot find a single piece of evidence to support any contention that anyone in the Defense Department or any other Department of the Government said it.

"...reawakened my interest in learning more theory, particularly solid-state techniques."

> Very interesting. So how come the Extra Class exam has no more about solid state than it did five years ago?

"...I'm now ready to apply for another DXCC endorsement."

> A total non-sequitur. 90% or more of the avid DX'ers are in the general class. And no single group has been more opposed to Incentive Licensing that the generals. And, incidentally, no other group has lost more frequencies.

"...recent polls *taken by the League* (my emphasis) concerning policies indicate our League ...is tapping the members for new ideas."

> This is certainly news to every ARRL member. Where in the world has this guy been? Or out of the world?

"...believed for years that strength in amateur radio is the quality and not the quantity of operaters."

> So who's claiming that Elements 4A and 4B will transform lousy operators into good ones? This is arrant nonsense, and I can't believe that even the fellow who wrote it, actually believes it.

"...I consider the League to be the most important and most influential driving force in amateur radio today."

> True. But how much better it would be if it were also the most democratic and representative force as well, instead of a complacent, self-satisfied, unresponsive one.

"...the majority are behind and beside you.'

> Evidently he means the majority of Directors, SCM's, and other League appointees, none of whom ever seem to have any differences of opinion with the official line. The same writer states further...

"...minority which invokes to force its will ...by their own selfish, self-righteousness and narrow-mindedness they will destroy."

> A clear case of the pot calling the kettle black. The only minority forcing their will in this fashion is the entrenched minority in Newington. The membership, not the leadership, is the majority. And the total League membership is but a minority within the total ham population.

"...I think the number of Extra Class operators will increase greatly after November 1969.'

> If FCC believed this canard, why did they finally rescind the Phase Two CW provisions wholly? The FCC examined Phase One in retrospect, and found nothing to indicate that further implementation as originally projected, for CW, at any rate, would accomplish the expected results. This idea stated by the correspondent was based solely upon the wishful thinking of the original proponents of re-structing. How egotistical to refuse to allow for the possibility that they might have been wrong in the first place.

Well, folks, as I said in the beginning, some damned fools'll swallow just about anything! Nicht wahr?

* * *

In November of 1963, when President John Kennedy was assassinated in Dallas, a tremendous hue and cry went up to illegalize firearms. Despite the furor and the public clamor for action, the final upshot was that no effectual legislation was enacted. Why?

Later, when Rev. Martin Luther King, Jr., and Senator Robert Kennedy were gunned down, similar demands, ever more insistent, were made. Again the movement toward firearms control was circumvented. Why?

Every single time a program of anti-gun laws is instituted, it is anticipated, met, and foiled. Why is this always the case? And how does it come about?

The answer is no mystery. One force, dedicated to one purpose, has withstood all these attacks for many years. The National Rifle Association has stood between these public onslaughts and the Second Amendment to our Constitution, part of our Bill of Rights, which guarantees the citizens' right to bear arms!

Well, how is the NRA able to accomplish this Herculean mission? It does so through the so-called "gun-lobby." What is a gun-lobby? It is a combination of forces, within and outside of the NRA, which, by many methods, constantly works in the interests of the gun sport group in all possible areas.

It supports a large effective information center, which publishes and distributes educational material, legislative bulletins, news letters and other printed matter. It works in conjunction with state fish and game authorities, training youth in safe gun handling, and authorizing the issuance of hunting licenses. This has alone created good

public relations, because it has cut down gun accidents tremendously. It engages in legislative propaganda among members of the Congress. It issues press releases which acquaint the public with the positive side of gun sports. It keeps in constant touch with the gun owners, hunters and collectors, urging them to write to their representatives in the Senate and the Congress. In short, it does a job of public relations which has been eminently successful in protecting the interests of this particular group of American citizens.

You can go down the line. Hundreds of organized groups have maintained their security from unwarranted attack (and sometimes warranted attack) by means of this method. Medicine, manufacture, finance, press, radio and TV, agriculture, shipping, veterans, mental health groups, fraternal organizations, religious groups, trade unions. . .and countless others.

And what is Amateur Radio doing while this is going on? I'll tell you what Amateur Radio is being told to do. It is being advised to volunteer for the Kiwanis club luncheon, to put on a hobby show for the local PTA, to write a little story for the business house organ, to deliver a message to a serviceman's mother and then tell the local press about it, etc., etc.

When is the League going to wake up? When is it going to realize the fact that we need to get into the water in order to swim?

Thousands of dollars are being accumulated by the League, yet it refuses to spend any of it in the interests of Amateur Radio. We could be doing a splendid job of public relations in Washington, D.C., where it would really count; among the lawmakers of this Nation. We could be accomplishing more good for ourselves and our hobby in one month that in the ways suggested by the League in twenty years!

Well, what's the objection to establishing such a program? Only this; that we might jeopardize our tax-free status. Can you imagine it? The main reason we are not doing this is for the sake of saving more money; taxes, in fact! What is the League intending to do with the money it amasses thus? Goodness knows. I don't!

It is freely admitted that we must have a good public image. I quote from a recent issue of QST. . .

> "Good public relations are important to nearly every society, corporation or charity, but especially important to us—our very licenses depend upon our activities being in the public interest, convenience or necessity. We must leave no doubt in the minds of the public that we fill this requirement to overflowing."

Very nicely put, Mr. H. Now, how about the League putting its money where its mouth is?

Case rests!

* * *

POEM

Murphy saw the tube turn blue,
Said, "I know just what to do,
Disconnect the braided strap
From the final's anode cap.
Pull the tube out, gently rock it,
Put a fresh one in the socket.
Peak the grid and dip the plate,
Dive right in, don't hesitate."

Murphy said, "There's nothing to it."
Then he set about to do it.
Stuck a folded-up match box
In each of the interlocks.
Grabbed the tube that had been gassy
Didn't ground it to the chassis.
Plus. . .he left the AC wire
Plugged into his rectifier.

Thunder, cannons, rockets, guns,
Stars and comets, moons and suns,
That's what Murphy heard and saw
When he disputed Murphy's law.
R. I. P.

. . . Dave Mann K2AGZ

(continued from page 2)
the rarer countries and would like to thank the operator for helping to make amateur radio more fun for you. In addition to cards, you might take a look around your cellar, attic, workshop, garage, barn, or whatever and see what radio equipment or test equipment you have stuck away that you can manage to do without. A lot of this stuff is too much trouble to turn into cash or really not worth all that much for trading, and could use a good home. This gear, which is just junking up your place, is needed desperately in dozens of countries and can help the cause of amateur radio incalculably if you will take the time and trouble to get it where it is needed.

How do you find out where to send equipment? Well, if you are active on any of the DX bands all you have to do is ask any of the ops you contact just about anywhere in Africa, Asia, the Pacific area, and any other remote island or country. ! doubt if you will find one of them that does not know a number of fellows who would like to be on the air, but cannot possibly afford to buy the equipment.

If you are not a DX'er, then you can pick up a copy of the foreign edition of the Callbook and find most of the amateur radio societies of the world listed there. Just drop them a letter explaining what you have in mind. I think you will find them cooperative beyond your expectation. Pages 116-117 of the 73 DX Handbook list foreign amateur radio societies.

The DX operator will explain how to ship the equipment (and parts). In many cases it is best to ship the equipment with the tubes and perhaps the power transformer removed, sending it as inoperative used equipment. The tubes can go later as used tubes. They may not need the transformer since their power is probably 220 volts, or worse.

There may possibly be a country in Africa, the Middle East, the Far East (except Japan), or the Pacific where amateur equipment is not in great need, but I doubt it.

New Year's Resolutions

Trite, I admit, but still a worthwhile concept. 1970 is a new year, and we all have a good chance to be better people this next year. Perhaps we can do a little better at keeping our cool when there is a pileup. Maybe we can sit back and listen a little more while others are falling apart jamming the channel with wasted rf. Perhaps we can try a little harder to maintain our dignity when attacked or annoyed by some idiot or rascal that is using his amateur radio license as a means for airing his psychological problems. One of the main marks of maturity is not seriousness, but the ability to not be *forced* to react emotionally when provoked. Can someone *make* you mad? There is a world of difference, psychologically, between getting mad at someone because it is the best and appropriate response to his actions, and getting mad at him because you can't help yourself. In one case you are in control of yourself, and in the other *he* is in control of you. The mature individual is a self-determined person, not one driven by the emotions of others. The mature person is freely emotional, not just closed down like the schizophrenic.

In practice this means accepting the immaturity of others with good spirits. When the QSO is interrupted by a break-break-break, you acknowledge the chap, but explain to him that you wish that he wouldn't do that. . . that he wait until a contact is completed unless he has urgent traffic. When you hear something on the air that makes you mad, hold that switch. . .try and reason *why* this is bugging you. No matter how terrible the provocation, your angry response just can't help matters.

Many operators, particularly the newer ones, are thoughtless and inconsiderate. Children are this way too, and the cure is education. Unless the op is in the throws of a serious mental breakdown, he will learn if given the information in a friendly way.

The most serious mental illness of the aged is said to be self-righteousness. Try not to age before your time and help people as friends rather than being overbearing or inclined to lecture.

CW vs RTTY

The results of the Armed Forces Day code and RTTY copying contests are interesting. 466 copied the CW message and 424 copied the RTTY message! Perhaps that tells us something about the direction that things are going. By next year the RTTY'ers may outnumber the CW ops.

Where Are They Now?

Way back in 1942, while getting my radio fundamentals at the Radio Materiel School on Treasure Island, I ran across a bunch of ham call letters listed on a bench in building 9B. For some reason I copied them down, thereby preserving them for posterity. Does anyone know where these fellows are these days? In 1942 they were among the tens of thousands of amateurs who turned their hobby into a valuable asset for their country.

W9LSX	W9OCX	W6SJB	W8RVX
W8CXY	W3HYL	W9KKA	W3FGA
W7FOP	W6UKE	W9GED	W4BAD
W6FUK	W6LLS	W5IRR	W7HAD
W3HZM	W7FHM	W7HSL	W7GOF
W9AUQ	W6EQS	W6ERM	W9AOP
W5GYK	W4EXG	W6ECB	W7EXB
W7EWM	W8TWT	W7IZL	W1MA
W6ECB	W5ATC	W9KLR	W5IIA
W1MWY	W9YAL	W6QEH	W9CSE
W9XER	W2JDT	W1MOL	
W4HVR	W3IXD	W1KQF	

Improving the Station

In my travels around and my contacts on the air I am surprised at how many amateurs are making do with a lot less equipment than they could be using. Sure, you can make contacts with inexpensive unstable gear, running low power and a poor antenna, but the contacts are a lot better and more fun if you have a beam up there and are running at least medium power. You don't have to have a twelve element beam up on a $10,000 rotat-

ing pole to have a substantial signal around the world, just a plain three element single band beam or a quad up thirty feet or so. For well under $250 you can have a nice crank-up tower, beam and rotator, so expense isn't a real excuse for most of us.

When you operate from the more remote spots in the world you begin to appreciate the value of a good signal. The ops in Afghanistan can hear the loud signals just about every night. The medium strength signals come through several times a month. The low power boys are heard a few times a year. It doesn't take much time from a location like that before you begin to look at the matter of power from a much more practical viewpoint.

. . . Wayne

Buy or Rent?

If you have a job to be done around the house and do not have the proper tools or equipment, you can find many shops that make a practice of renting everything from simple hand tools to complex machinery. The radio amateur who wants to make a one-time test requiring an expensive piece of test equipment has no such opportunity. If he works at a place using the desired equipment, sometimes he can arrange to borrow it. Usually, though, he has to buy a seldom-used item, which sits idle thereafter, perhaps never to be used again.

Why hasn't somebody established a business of renting electronic test equipment? A good question. . .and one that has been answered. LeasaMetric has issued a catalog listing hundreds of items of test equipment that may be rented at reasonable monthly rates. The company has branches in many cities (I counted 33) in all sections of the nation. No amateur should be too far from one.

This leasing or renting service should solve many problems for the serious experimenter. For instance, suspose you want to test a new SSB transmitter you've built. The only way an SSB transmitter can be tested so as to show its behavior under the transients of speech is with a spectrum analyzer having a speedy scan rate. Unfortunately, the least expensive model of such a device costs about five times as much as the most expensive SSB transmitter on the amateur market. The solution is to rent one.

Interested? Contact LeasaMetric, 4580 East 50th Street, Tulsa, OK. 74153.

. . .Carl C. Drumeller, W5JJ

LETTERS

Dear Wayne:

I just recently bought 30 back issues of your mag. (I'm fourteen and that is the kind of term we use.) I've been reading them day and night and I've just about blown my mind on page after page of technical and constructional articles. But I'm hooked!

Mark Salisbury WA2EWK
Kitchell Road
Convent Station, NJ 07961

Dear Wayne,

There are some pretty good possibilities for amateur talents in Radio Astronomy. Presently, there are about fifty or so individuals who have banded together and formed the Society for Amateur Radio Astronomers. The address is: Society for Amateur Radio Astronomy, Flat 5, 68 Derby Road, Heaton Moor, Stockport, Chesire, SK4 4NF, England. The annual membership dues are $3.50 and include *Radio Sky*, the society journal. But I have an idea that although they may make use of amateur techniques, that they are not licensed amateurs and consequently, not very knowledgeable.

I put together and operated an interferometer at 137 mhz a couple of years ago in Illinois, but due to space limitations I haven't been able to do anything like that here in Michigan. But I know I could certainly put together a small dish. . .or stacked beams as one-half of a phone-linked or radio-linked interferometer pair. (With amateurs doing Moon Bounce at VHF and UHF, they could certainly do a good job at Radio Astronomy.)

I think the idea of aperature synthesis is particularly interesting.

Albert G. Krieger W8BXV
1063 Cranbrook Drive
Jackson MI 49201

Dear 73,

K1CLL's article in the September proves once again that 73 is the most progressive HAM publication. Bill's theories are interesting and would explain several confusing problems presently facing physicists but are open to question at several points. The slowing down of a vortex wave without a decrease in flux density ("increase in volume") is probably impossible. "Friction" would not be responsible because individual photons have never been affected by any other wind. If the slow down is the result of photons losing energy without expanding, the photon mass would be inversely proportional to velocity–this is impossible. If the slow down is the result of energy soakup, the photons would be more energetic but still confined to the same volume; this violates the entropy law.

K1CLL also confuses the role of Fourier analysis in his super-short pulses. When information is broken down to N components and transmitted on N channels simultaneously the waveshape is unimportant. Instead of denying that short pulse-X can be analyzed (which it can), it should be said that any amplitude modulation present carries no information; only the aggregate effect of the various frequencies is meaningful. Actually, Fourier analysis takes amplitude vs. time waves and converts them to a specific set of periodic waves which are pure carriers of varying intensity.

John T. Nogatch WA2FDR/6
California Institute of Technology
Pasadena CA 91109

Dear Youth Editor,

You started your Sept. letter by saying youth is speaking out all over the world. I wonder if this is the reason for all the unrest throughout the world now. On whom are you putting pressure, the mothers and fathers who no doubt were too kind?

Funny thing, this country has reached an economic condition where only the disabled, sick and lazy do not work. This prosperity certainly was not brought on by the so-called teenagers.

As much as I disagree with the policies of the ARRL, I agree with its rule whereby a person must be of age to become a director. I have worked many teenagers on the bands and enjoyed their bright enthusiasm. They all seemed to show a certain amount of respect for an old timer. As a youngster, I had the highest regard for the fellows before me because they made it possible for me to enjoy a wonderful avocation. Then there are others like you who think with the possession of a little knowledge, you should be allowed to run everything. We seek your participation, suggestions and know-how but to become president of this grand country, I advise you to wait until you reach the constitutional age. Our founding fathers were not teenagers but I strongly suspect they knew what they were doing.

By the impatient trend shown by a very small minority of our youth, I have concluded that they think they will remain at age twenty or die at that ripe old age. What happens when they reach maturity? Do they fold up and say "let the kids do it"?I have an idea that when they get older they will get pushier.

So in a friendly manner I say to you, an older guy never has to get young but if you are lucky you will have to grow old. Think about it.

Until recently, the hams have been members of one big fat fraternity. Now added to the controversy created by incentive licensing, there are those, like you, who would pit young against old. OK, let the older ones take their assets out of circulation and let the kids start from scratch.

Come on, fellows, regardless of age or any other thing let's go back to having a little respect for each other, like.

Theodore DeCrescenzo W2DAD
244 Columbia Avenue
Jersey City NJ 07307

Gentlemen:

This morning I heard WA1KFJ come out with what must be the hardest-to-understand phonetic of the month, when he referred to K1MON as K1 Motion Ocean Notion. It doesn't take gnu, xylophone, and mnemonic to blow somebody's mind.

John A. Carroll K6HKB/1
34 Clark St. Apt. 13
Arlington MA 02174

Dear Wayne,

I am 18 years old and have been a ham for a little more than five years. So I guess I am relatively new in Amateur Radio compared with most hams and especially the Old Timers. I thought WA1GEK's article, ' Youth Forum," was simply an outlet for his frustration of maturing. Reading it objectively (which is hard for some of us teenagers sometimes) it sounds like he just wanted to use the article for an attack against the "establishment" which supposedly restricts so much freedom from teenagers.

Certainly I don't mean to say that I agree with everything the ARRL does, but I don't really see the urgent need for a teenage SCM. Why not try to influence the League's policies by writing to the SCM's, directors and other officers already in elected positions?Then there is also the question of whether or not a teenager has a sufficient amount of time for the job of that importance. We have our college or school commitments and some of us have time in the armed forces to do, and we like to run around a lot. I find it hard to believe that a responsible SCM consciously discriminates against teenagers who run for office if they have the ability for the job.

The article starts by briefly relating the youth protests against alleged evils of former generations. This discontent does little to improve the situation and many teenagers make it worse by dropping out and going hippy, yippy, or just plain left-wing reactionary.

Sure many adults are "dead from the neck up," but we should learn first how to become a more responsible, mature citizen before stepping in where perhaps wiser people fear to tread.

To affect productive changes in the existing order we must pursue a rational program with Old Timers helping younger beginners instead of repelling them from our great hobby-service by making distasteful remarks pointing up our inexperience and immaturity which we so desperately try to hide.

I think we accomplish more as hams helping other hams rather than as divided into "young generation hams" and "old generation (also called dead, apathetic, snobby, old fogie, etc.) hams."

Some minority groups in my generation question old standards and principles. We must realize that these ideas and institutions have the positive aspect of being time tested and have proved their soundness through more years than we have existed. Many can be improved; things must change with changing times in order to adapt to new situations and customs and to continue to be versatile. But things must change for the better. Indiscriminant experimentation can lead to confusion and regression rather than progress. It has been said that progress follows order. We shouldn't make hasty changes in basic institutions. Only until we believe it will be better after careful consideration can we modify existing ways.

I certainly hope ham radio will continue as one of the world's best hobbies. It can through mutual co-operation between the OT's and the beginner.

Sam Wells, Jr. WA5KTW
Box 7128
Louisana Tech
Ruston LA 71271

Dear Wayne,

Regarding your comments about the diet colas, etc., this summer we started buying Tab (Coca Cola Co.) for the first time. Almost at the same time both the XYL and myself became bothered by constipation. I came to the same conclusion you did, that the warning on the bottle is just exactly that. However I took it lightly the first time I read it, due primarily to the indiscriminate way they advertise those diet products–for everybody! The FDA of FTC should get on those companies. I'm convinced on the basis of your experience and ours that they are harmful if consumed by the non-diabetic.

Robert G. Wheaton W5PKK
White Farm Dr., RR 2 Box 324D
San Antonio TX 78228

Dear Sir:

We are pleased to inform you that, on our representation, Wireless Planning & Co-ordination wing of the Government of India, the Licensing Authorities in India, have permitted Indian Hams to operate under a new prefix VUØ from 1st to 31st October 1969 in celebration of Mahatma Gandhi Birth Centenary Year.

We have also pleasure to inform you that we shall issue a Special Award "Mahatma Gandhi Birth Centenary Award" for 10 contacts made with VUØ Hams during this period. Contacts may be made on any mode and band as permitted to Hams.

Log extract for 10 VUØ contacts with eight IRC's to be sent to: R. E. S. I, Post Box 6538, Bombay - 26.

Saad Ali VU2ST
Hon. Jt. Secretary
Radio & Electronics
Society of India

Dear Wayne,

Your comments re Marathon Nets (Oct. '69), are reasonable and fair, and with them I concur. I am not a net enthusiast, and therefore seldom check into them; but, I am aware of their utility and am glad to QSY when in their way.

It is, however, a pet peeve of mine that, on occasion, when having moved by request of net control to another frequency, two net stations (with kilowatts!) QSY from net frequency on top of me to pass traffic without consideration of others whatsoever! Here, in my view, is a practice of participating stations which needs attention.

Your tenth anniversary special is superb.

Guy N. Woods WA4KCN
4921 Edenshire Ave.
Memphis TN 38117

Dear Wayne,

I honestly cannot understand why there are so many detractors, and so few who stand behind the rulings of the FCC for Amateur Radio. Why do so many complain of the difficulty of learning CW and about incentive licensing?

How much knowledge one accumulates with so little effort is worth taking a moment to consider. How many words (in only the English language) does the average individual know by sight as well as sound? Words that are peculiar to a particular trade or hobby are known and used without second thoughts–and some words-peculiar are real lulu's, as anyone who has taken up a hobby know. And yet, individuals who have learned to read, write, hear and talk a language as difficult as the English language find it difficult to learn the sound of 26 letters, 10 numbers, and an additional 20 assorted characters–a mere 56 items to commit to memory. Totally insignificant when compared to the myriad of things one knows and recalls with little or no effort. As examples: telephone numbers of friends and associates–anniversary dates & birthdates–coins and currency values–street names and addresses–recognition of probably a hundred models and makes of automobiles–and so many more things that we consider so commonplace that we do not consciously realize that we are learning them. And still the thought of learning the code terrifies some people. Why? A little effort, coupled with the desire to become an amateur, is all that one requires to master the code.

Incentive licensing is here to stay, and I, for one, am in favor of it. About the same time as I was first licensed (1952), the real incentive licensing ceased to be. My Conditional license was just as good as my friend's Class A, for there were no bands I could not use, nor any mode of transmission that I could gain by getting a higher license. Without Incentive Licensing, I would undoubtedly still be a Conditional, and would remain so unless the FCC called me before an examiner. But, being of the 'old school' of Americans and despising restrictions, the threatened loss of even a small part of my operating privileges goaded me into obtaining the extra class license. If any other class of license is ever issued with attendant privileges, I shall endeavor to obtain that one, too, if for no other reason than self-satisfaction and the privilege of operating on any authorized frequency that I may wish to try.

By the way–for the edification of George Taylor W4PZS, not only do my old friends still talk to me, but I have made many new ones as well. I recommend that he try it instead of knocking it.

R. E. Smith W5VFZ
Box 97
Organ NM 88052

Gentlemen:

The Super-Gain Antenna for 40 Meters which was frequently mentioned over the air during the latter part of September intrigued me to the point that I drove over to a neighboring city, Eau Claire, and purchased an October "73." Incidentally, last Saturday I erected a "Super-gain 40 meter skywire" as described and it works like a charm!Thus my introduction to 73 Magazine, and I am pleased by its contents.

Wayne M. Taber W9BLU
422 Macomber Street
Chippewa Falls WI 54729

Dear Wayne,

Your article *Youth Forum* in the October issue was nice, but I hope you don't expect any smashing results. If you want teenagers taking over the leadership posts of amateur radio, that's fine, but I know of no teenagers that are responsible and creative enough for a leadership post of any importance.

Some teenagers are loaded with ideas and want to be heard, but after you listen a while you find they dislike everything as it is and want change, but ask them how the changes should be made, and there is dead silence.

O.K., so you think that this is all wrong! Well here is another point. Teenagers are busy, very busy. They are tied up in school and school studies around 35 hours a week. Most teenagers have part time jobs, there is another 10 hours a week. Then add to this all the social activities and you have a very busy schedule!

What gives me the right to say all this? Well, I'm a high school senior, 17 years old, an Advanced Class amateur, and RACES officer for our county. I'm ashamed to say it, but with all my activities I just don't have time to do a good job with my RACES duties (unfortunately no one else seems to have the time either). I feel that other teenagers will find the same thing to be true, despite what they way, if they hold posts such as SCM, EC, or any other posts of leadership.

Chuck Schmidt WA9ZEH
306 East Vienna Street
Anna IL 62906

Gentlemen:

There has been a reorganization of the Post Office in Britain, as a result of which the Department to which applications for Reciprocal Amateur Radio Licenses should be made, has changed its name.

The new name and address is: Ministry of Posts and Telecommunications, Telecommunications & Radio Regulatory Department, Radio Regulatory Division, Amateur & Special Licensing Branch, Waterloo Bridge House, Waterloo Road, London, S.E.I.

N.A.S. Fitch G3FPK
Honorary Secretary
BCM/ARMS
London W.C.1

Dear Wayne,

Several months ago I completed the construction of a CW-AM rig which was featured in the 1967 ARRL handbook, 120 watts input with a 6146B in the final. I have been an inactive ham for many years and decided to build this rig so I could operate AM instead of CW only. It has been a source of great pleasure and pride to operate this fine little transmitter. It is used mostly on the 10 meter band on AM. The antenna is a Mosley RV4C vertical which deserves a review in 73 magazine.

I have always built my own transmitters since I felt that an amateur should be interested in making a thing he created himself speak for him and his hobby.

Since there seems to be such a great exodus from the AM ranks to the SSB ranks, for obvious reasons, many hams with a considerable investment in good AM equipment seem to be forsaken. This equipment is good for a trade in value on SSB equipment.

We are given many reasons why we should go SSB but no one discusses the financial part of this changeover. This equipment is expensive and must certainly be one of the major factors involved.

There is concern about how few people join the amateur ranks each year, but consider what a novice has to look forward to.

After he acquires his General Class license he most probably will want to do some phone work in the portions of the amateur bands now open to him. Consider at this point his frustration over the financial outlay he is now faced with. SSB equipment is not easy to construct so he probably pur-

chases used AM equipment and then finds he has practically no one to talk to except on 10 meters. I'm not knocking 10 meters however since as you see, I'm working this band myself and I have had a lot of fun doing so.

"73" should attempt to lead the way in this SSB changeover by featuring simple, low cost, low power transmitters and then perhaps we will find more of the AM fellows willing to make the changeover, and this would perhaps be of assistance to the novice who I believe has a problem.

In past years many good construction articles were used by the commercial builders to place on the market equipment amateurs found useful. If these builders found low cost, low power SSB equipment filled a need to certain members of our ranks, perhaps we would see some of it on the market.

I believe more of the old timers would make the changeover if it wasn't necessary to sell the XYL's mink coat and jewelry to do so.

In any event "73" is a great magazine, keep up the good work.

John A. Hunt WØPOF
10626 St. Matthew
St. Ann MO 63074

Dear Wayne,

Thanks for the PC boards–it looks like an excellent job. The VFO seems to be working out well because I have had only one complaint from a guy who tried to use some HEP experimenter's transistor instead of the MPF-102. The MPF-102 usually must be obtained from a Motorola dealer or catalog rather than a general radio supply store. Another problem I found is that the output voltage is inadequate to drive some transmitters on all bands. This can be helped by adding a tuned circuit at the output of the amplifier with a few turn link coupling to the collector of the transistor. A toroid transformer would be more efficient and not have to be tuned, but I don't happen to have any toroid cores at the moment.

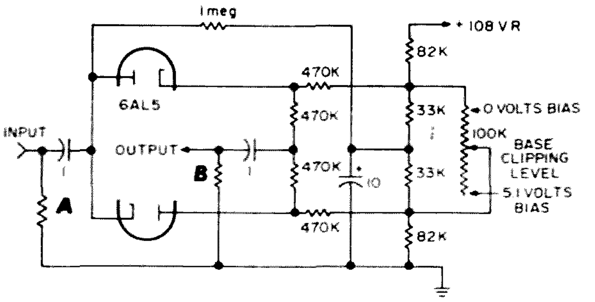
Cliff Klinert WB6BIH
520 Division St.
National City CA 92050

Errata & Addenda

Base Clipping—September

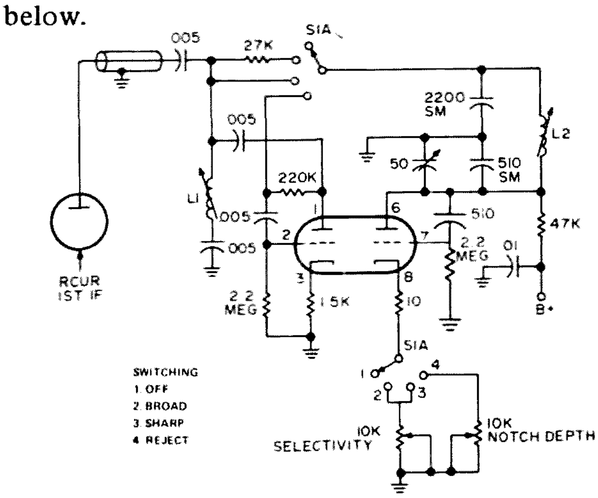
Figure 5 of the article "Improvement of Phone Intelligibility by Base Clipping" on page 69 of the September issue of 73 showed the input connected directly to the ground in the circuit. Quite a few readers caught this error and wrote to Ronald Ives, the author, about it. The corrected schematic is shown at the top of the next page.

A is the output load resistor of the leading circuit, whatever value it may be. B is the input resistor of the following circuit, whatever value that may be.



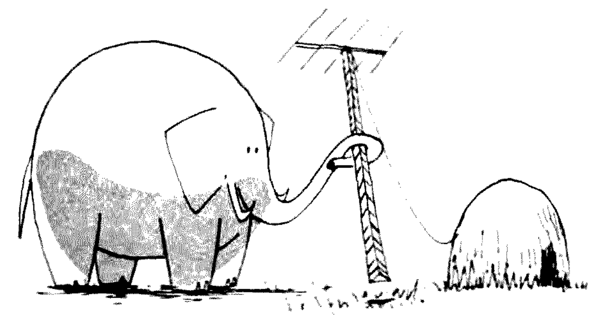
Q-Multiplier—October

Robert Grenell ex-W8RHR has let us know that the schematic for his Q-multiplier, illustrated in Figure 1, page 68, October 73, was missing some important bits of circuitry. The correct and complete schematic is given below.



The Ball of Wax, A Calibrator—November

The pc boards and a parts kit for the calibrator presented by Henry Olson W6GXN, in the November issue, are available from A.R.S. Enterprises, Box 555, Tempe, Arizona 85281. Due to an editorial oversight, this supplier's name was omitted from the article. Our apologies to A.R.S. Enterprises and to W6GXN.



"Lotta QRM all of a sudden, Jesse . . . hold on a moment and I'll go check the antenna connections."

Caveat Emptor?

★ **Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

★ **Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.**

★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

★ **We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.**

★ **For $1 extra we can maintain a reply box for you.**

★ **We cannot check into each advertiser, so Caveat Emptor . . .**

NEMS-CLARKE RECEIVERS WANTED. 1400 Series crystal controlled telemetry models covering 215-245/260 MHz preferred but all models in 1300, 1400, 1500, 1600 and higher numbered series also of interest. Please send accurate description of what you have to TUCKER ELECTRONICS CO., POB 1050, Garland, TX 75040.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $2.50 postpaid. Elliot Buchanan & Associates, Inc., 1067 Mandana Blvd. Oakland, CA 94610.

3 PLASTIC HOLDERS will frame and protect 60 cards, $1.00—or 10 holders $3.00. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, TN 37066.

NOVICE THREE-BAND DOUBLE INVERTED-VEE: Tuned assembled SWR. Under 1.5-1 15-40-80 Novice bands. W3FQJ Design, $15.75. Antenna Products, Box 276, Warrington, PA 18976.

WIRELESS SHOP—new and reconditioned equipment. Write, call or stop for free estimate. 1305 Tennessee St., Vallejo, CA 94590 (707-643-2797).

"TOWER HEADQUARTERS!" 11 brands! Heights aluminum 35% off! Strato crank-ups, low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog—$.20 postage. Brownville Sales Co., Stanley, WI 54768.

COLOR ORGAN KIT, three 200 Watt Channels, $7.50. Cabinet, $8.50. Power Supplies, $2.75 to $8.50. Ceramic Capacitors, $.10. Dual Flasher 1000 Watt, $3.98. 1000 Resistors, 1/2 Watt, 5%, 1/2" leads, $2.00. TV Cheater Cord, $.25. Catalog. Murphy, 204 Roslyn Ave., Carle Place NY 11514.

73 IS AVAILABLE to the blind and physically handicapped on magnetic tape from: SCIENCE FOR THE BLIND, 221 Rock Hill Road, Bala Cynwyd, PA 19004.

ROCHESTER, N. Y. is again Hamfest, VHF meet and flea market headquarters for largest event in northeast, May 16, 1970. Write WNY Hamfest, Box 1388, Rochester, NY 14603.

UCS-300 VACUUM VARIABLES (10-300pfd at 10kv) with manual drive unit, $25.00. SK-400 metal sockets for 4-400A, $5.00. F.M. Powell WA4ETD, Box 106, Fayetteville NC 28302.

GREENE. . .center dipole insulator with. . .or without balun. . .see 73, November '69, page 107.

THE AUSTRALIAN EEB is only for enthusiastic Electronics Experimenters. Send for sample copy. The Australian EEB, P.O. Box 177, Sandy Bay, Tasmania 7005, Australia.

SELL: NCX5 MK2 spk/AC-PS, xtal calib, mint cond, little used, $400 firm. HQ-180, noise blanker, all new tubes, $200. Viking I AM-DSB-CW, 160-10M, VFO, Dowkey Relay, 2 unused 4D32 finals, D-104-G stand, $100. 6N2, all new tubes w/ps, Dowkey Relay, $100. Filter King 6M conv w/ps, $15. 2–8122 unused finals, $50. Will ship. 513-561-5330. Curt Gamble, 7283 Thomas Drive, Cincinnati OH 45243.

INTEGRATED CIRCUITS: new Fairchild Micrologic; epoxy TO-5 package. 900 buffer, 914 gates, 60¢ each; 923 J-K flip flop, 90¢ each. Guaranteed. Add 15¢ postage. HAL Devices, Box 365W, Urbana, Illinois 61801.

COLLINS S LINE 32S1, 75S3, 312B4 complete. A-1 Condition, $895.00. First Money order or certified check takes all. Raymond C. Miller K2QWG, 25A Hillcrest Rd., Warren NJ 07060.

COMPUTER BOARDS-over 30 silicon transistors, tantalums, diodes, some with several trimpots. Two sizes 6 x 11 @ $3.00; 6 x 7 @ $2.00 plus 30¢ postage. Check or M.O., aquarius enterprises, box 20898, Dallas TX 75220.

WORLD RADIO used gear has trial-guarantee-terms! KWM2–$695.00; G50–$159.95; SR150–$299.95; SR160–$169.95; Swan 250–$279.95; DuoBander 84–$119.95; 753–$129.95; TR3–$369.95; NCX3–$169.95; NC200–$249.95; SB33–$199.95; SB34–$299.95; Galaxy 300–$139.95. Many more and free list. Write Box 919, Council Bluffs IA 51501.

SELL: HT37 SSB TRANSMITTER $165., SX111 SSB receiver $ 10. Both in mint condition with no modifications. Pickup only. W6OIH, 10844 Woodward Ave., Sunland CA 91040. 213-353-4062.

ESTATE SALE: Three complete Collins setups, owned by late Dr. Sam Sosnov, includes 75A4, KWS-1, 30L1, KWM2, etc., with all accessories plus new tower and beam. Equipment now stored at W6AG and priced right for fast sale. SASE for complete list with prices asked. 213-764-4401. 13048 Cantara Street, N. Hollywood CA 91605.

DYNAMOTORS, PE-101C, 600/300 volts at 200 ma, 12 volts input. $3.95 plus 13 lbs postage. Free data sheet. Bedford Electric, Box 16, Bedford MA 01730.

ARC-27 UHF transceiver, RBL-3 VLF receiver, BC603 w/ESSA Satellite Conv. Dynamotors, miscellaneous. SASE for list. J.D. Wood, 201 Montebello, Charlottesville VA 22903.

FOR SALE: Drake TR-6, all accessories, 3 months old. $750.00. Cash or consider Swan 250-C. J. Gysan W1VYB, 53 Lothrop St., Beverly MA 01915.

SELL: SR160 transceiver, matching AC, DC power supplies, cables, complete, $275.00. HQ170 AC like new, $250.00. WA9NII, Owen Station, R 1, Crawfordsville IN 47933.

HEATH IM-17 Solid State Voltmeter—$14; Knight P-2 SWR Bridge, $10; James Research Oscillator/Monitor Mk. 2, $10. Daniel Seidl, 17 Pine Avenue, Kane PA 16735.

SELL: DRAKE 2-C Receiver, 2-CS Speaker mint condition, no scratches, with original carton—$210. Dow-key T-R switch—$10. Johnson Adventurer novice transmitter—excellent condition—$25. Heath GR-64—$20. Heath GD-125 Q-multiplier—$10. Lafayette 99-1015 signal generator—$15. WB8DBN, 16260 Greenfield, Detroit MI 48235.

MERRY XMAS and a HAPPY NEW YEAR from WØCVU. Join the Old Timers Club if licensed for forty years. Send QSL card for application. Chas. W. Boegel, Jr. WØCVU, 1500 Center Point Road, NE, Cedar Rapids, IA 52402.

INTEGRATED CIRCUITS 20 page article. Anyone can design successful projects. Send $1.00. Solid State Tekneex, Rt. 1, Doniphan MO 63935.

SALE: MINT R4A T4XB with extras. Power supply with speaker and case. Cables and manuals. $695.00. W6GC, 737 12th Street, Manhattan Beach CA 90266.

COLLINS 51J3—immaculate—less than 1KHZ tracking error each band w/Collins Speaker, $395. CENTRAL ELECTRONICS 100V, $300. ELDICO R-104 (comparable to 75S1 w/2.1 and 0.5 KHZ COLLINS Mechanical Filters) $195. SP-600, $200. BC-221 w/power supply, $50. HORNET TB-750 w/new traps, $45. W8QJI/Ø, 16 Crestview Drive, Council Bluffs IA 51501.

SELL, HT37, mint, $200, 813's linear with power supply, $95, 65' EZWay tower, house mount, H.B. rotator, $90. W9IMS, 1204 Inverlieth Rd., Lake Forest IL 60045.

SWAP MATCHED PAIR RCA CMU-15A, UHF. Factory overhauled. New crystals, retubed, manual, all accessories, for two meter base. Gordon W2MPT, 25 Norma, Lincroft NJ 07738.

FOR SALE: 75S3 receiver, mint condition. $295.00. Fred Fetherolf, Laurelville OH 43135, phone 614-332-3421.

GENERAL ELECTRIC Station Type EU-DO37NK6 FM transmitter receiver 80 watt 150.8-174 MC. Mint condition, $475.00. J. Hoey, 25 Metcalf Drive, Cumberland RI 02864.

DAYTON HAMVENTION April 25, 1970: Sponsored by Dayton Amateur Radio Association for the 19th year. Technical sessions, exhibits and hidden transmitter hunt. An interesting program for XYL. For information, watch ads or write Dayton Hamvention, Dept S, Box 44, Dayton OH 45401.

SPECIAL OF THE MONTH RG 11V Coaxial Cable, 1st quality, Brand New—12¢ a foot or any length to 2500 feet. Antennas, Inc., Dept. B, 512 McDonald Road, Leavenworth KS 66048.

EICO 753 Transceiver. SSB-AM-CW on 80-40-20 mtrs, plus power supply/spks. Model no. 751, in original factory cartons, $170. Steven J. Bartha, 9 Dixon Ct., Sea Cliff, L.I. NY 11579.

WANTED: TEST EQUIPMENT HP608 generator, RX meter, 704 Jerrold FSM, 601, 900 Jerrold Sweep Generator, HP130 oscilloscope or equivalent. VE3BVX, 11 Sussex North, Lindsay, Ontario Canada.

SELL DRAKE AC-4 power supply, $89. Never used. Need education money. Jack Hermann W8TSF/9, 2409 East Nevada, Urbana IL 61801. Phone 217-367-3919.

SELL – SWAP: SB300 for SB110-A; HX-20, $95; power inverter 12 vdc—110 vac, 120 watt, $15; Gary Tater, 40 West St., Leominster MA.

600L CENTRAL ELECTRONICS linear amp—excellent condition. Price, $175.00.

DX ACROSTIC

Dave Mann K2AGZ

Unscramble the mixed-up words to form DX countries. When finished, the first letters form a key word, known to all hams. Clue: two devices in one.

1. RYUKET _ _ _ _ _ _
2. MARONIA _ _ _ _ _ _ _
3. RACACTINTA _ _ _ _ _ _ _ _ _ _
4. SANSAVA _ _ _ _ _ _ _
5. NIMSURA _ _ _ _ _ _ _
6. PLINPROCET _ _ _ _ _ _ _ _ _ _
7. CARUDEO _ _ _ _ _ _ _
8. RIALES _ _ _ _ _ _
9. CINCIVATATY _ _ _ _ _ _ _ _ _ _ _
10. SANDALEISTER _ _ _ _ _ _ _ _ _ _ _ _
11. GRUZORIDE _ _ _ _ _ _ _ _ _

(Solution on page 57)

PROPAGATION CHART

J. H. Nelson

December 1969

SUN	MON	TUES	WED	THUR	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
$\boxed{28}$	$\boxed{29}$	30	31			

Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14A	14	7	7	7	7	3A	7	14	21	21A	21
ARGENTINA	14	14	14	7A	7	7	14A	21A	21A	21A	21A	21
AUSTRALIA	21	14	7B	7B	7B	7B	7B	14B	21	21	21A	21A
CANAL ZONE	21	14	7A	7	7	7	14A	21A	21A	21A	21A	21
ENGLAND	7	7	7	3A	7	7B	14A	21A	21A	21	14	7
HAWAII	21	14	7A	7	7	7	7	7B	14A	21A	21A	21A
INDIA	7	7B	7B	7B	7B	7B	14	21	14	7B	7B	7B
JAPAN	14	14	7B	7B	7B	7	7	7B	7B	7B	7B	14A
MEXICO	21	14	7	7	7	7	7	14A	21A	21A	21A	21
PHILIPPINES	14	14	7B	7B	7B	7B	7B	14B	14	14	7B	14
PUERTO RICO	14	7	7	7	7	7	14	21	21A	21	21	21
SOUTH AFRICA	14	14	14	7A	7B	14	21A	21A	21A	21A	21	21
U. S. S. R.	7	7	7	7	7	7B	14A	21A	21	14	7B	7
WEST COAST	21	7A	7A	7	7	7	7	14A	21A	21A	21A	21

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	3A	7	14	21	21A	21A
ARGENTINA	21	14	14	7	7	7	14	21A	21A	21A	21A	21
AUSTRALIA	21A	21	14	7B	7B	7B	7B	7B	14A	21	21A	21A
CANAL ZONE	21	14	14	7	7	7	14	21A	21A	21A	21A	21A
ENGLAND	7	7	7	3A	7	7	7B	14A	21A	21	14	7B
HAWAII	21A	21	14	7	7	7	7	7	14A	21A	21A	21A
INDIA	7B	14	7B	7B	7B	7B	7B	14	14	7B	7B	7B
JAPAN	21	14	7B	7B	7	7	7	7	7B	7B	7A	14A
MEXICO	21	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	14	7B	7B	7B	7B	7B	7B	14	14	7B	14A
PUERTO RICO	21	14	7	7	7	7	14	21A	21A	21A	21	21
SOUTH AFRICA	14	14	7A	7B	7B	7B	14	21A	21A	21A	21	21
U. S. S. R.	7B	7	7	7	7	7B	7B	14	14	14	7B	7B

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	21	7A	7	7	7	7	3	14	21	21A	21A
ARGENTINA	21	21	14	14	7A	7	7	14A	21A	21A	21A	21
AUSTRALIA	21A	21A	21	14	14	7B	7B	7B	14A	21	21A	21A
CANAL ZONE	21	14	14	7	7	7	7	14A	21A	21A	21A	21A
ENGLAND	7B	7	7	3A	7	7B	7B	7B	14A	21	14	7B
HAWAII	28	21A	21	14	7	7	7	7	14A	21A	28	28
INDIA	14	14	7B	7B	7B	7B	7B	7B	14	7B	7B	7B
JAPAN	21A	21	14	7B	7	7	7	7	7	7B	14	21A
MEXICO	21	14	7	7	7	7	7	14	21A	21A	21A	21
PHILIPPINES	21A	21	14	7B	7B	7B	7B	7B	14	14	14B	21
PUERTO RICO	21	14	14	7	7	7	7	14A	21A	21A	21A	21
SOUTH AFRICA	14	14	7A	7B	7B	7B	7B	14	21A	21A	21	21
U. S. S. R.	7B	7B	7	7	7	7B	7B	7B	14	14	7B	7B
EAST COAST	21	14	7A	7	7	7	7	14A	21A	21A	21A	21

A = Next higher frequency may be useful also

B = Difficult circuit this period

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